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NOISE MONITORING TITAN III D LAUNCH VANDENBERG AIR FORCE BASE, CALIFORNIA

Ronald D. Burnett

Environmental Health Laboratory
McClellan Air Force Base, California

January 1975

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Prof Report No 75M-2
(Project No NAF-353)

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Vandenberg AFB CA

By

Ronald D. Burnett, Major, USAF

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Prepared by:

RONALD D. BURNETT
Major, USAF, BSC
Chief, Occupational Safety & Health
Engineering Division

Approved by:

DONALD D. HIGGINS
Lt Col, USAF, BSC
Commander

ABSTRACT

During a Titan III D launch at Vandenberg AFB, sound pressure levels were recorded on tape as a function of time at four distances varying from 8,400 ft to 44,000 ft from the launch site. One-third octave band data were obtained from the recordings using real time analysis techniques. Some limited vibration (acceleration) data were also collected at the La Purisima Mission, a historical park located approximately eleven miles from the launch site.

These data are discussed in relation to the environmental impact on communities surrounding Vandenberg AFB, and the damage potential of these launches to the La Purisima Mission State Historic Park. The environmental impact of noise at distances of eight miles or greater was insignificant.

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SECTION I

INTRODUCTION

1. Purpose:

a. On 29 October 1974, noise data were collected at selected sites on and near Vandenberg AFB, California, during a Titan III D launch. This survey was requested by the bioenvironmental engineer, USAF Hospital, Vandenberg AFB, California. These data were required to estimate the acoustical impact of missile launches on communities adjacent to Vandenberg AFB. Limited vibration data were collected in the chapel of the La Purisima Mission State Historic Park to determine the extent of vibration induced in these historical structures during launches.

b. Because of the similarity between the Titan III D and launch vehicle systems for the space shuttle, these data are also to be used by personnel of the Space and Missile Systems Organization (SAMSO) to estimate the acoustical impact expected from space shuttle launches.

2. Scope of Study.

a. Overall and one-third octave band sound pressure levels as a function of time were measured at four sites. The frequency distribution of peak and background noise was measured at each site.

b. One-third octave band acceleration levels were measured on a roof beam of the La Purisima Mission Chapel, having the longest free span.

3. Personnel Contacted:

a. Lt Col Lynn R. Channell: Chief, Environmental Health Service, USAF Hospital, Vandenberg AFB.

b. Mr Clark Pease: Programs Support Manager, Programs Division, Range Operations, SAMTEC, Vandenberg.

c. Mr Mason: Area Director of State Historic Parks, La Purisima Mission.

4. Personnel Conducting Survey & Survey Responsibilities:

a. Maj Ronald B. Burnett, USAF Environmental Health Laboratory (USAFEHL), McClellan AFB: Project Engineer and Vibration Measurements.

b. Capt Larry Shingler, SAMSO/SGX, Los Angeles AFS: Noise Measurement at Oak Mountain Site.

c. 1st Lt Harry P. Guy, USAFEHL, McClellan AFB: Noise Measurement at Tranquillon Peak.

d. SSgt Ed Cox, USAFEHL, McClellan AFB: Noise Measurement at Range Operations (Building 488).

e. Mr Philip Diamond, USAFEHL, McClellan AFB: Noise Measurement at SLC-3 Blockhouse.

SECTION II

SURVEY DESCRIPTION

1. Measurement Sites. The location of the measurement sites in relation to the launch site are shown in Figure 1. Table I indicates the name of the measurement location and its designation on Figure 1.

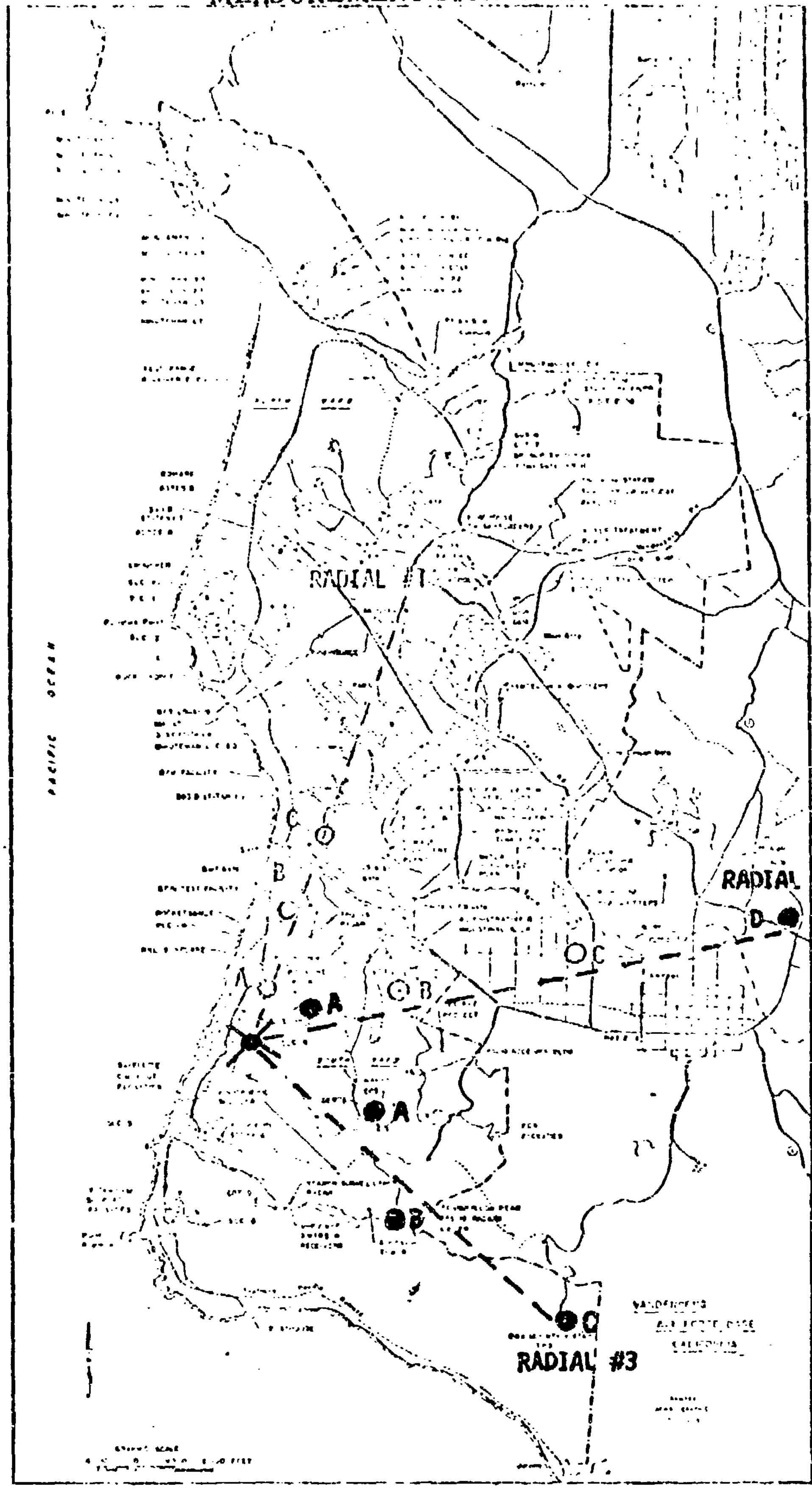
TABLE I

IDENTIFICATION OF MEASUREMENT SITES

	Figure 1 Designation	
Measurement Site	Radial	Location
SLC-3 Blockhouse	2	A
Range Operations (Bldg 488)	3	A
Tranquillon Peak	3	B
Oak Mountain	3	C
La Purisima Mission	2	D

FIGURE 1

MEASUREMENT SITE LOCATIONS



2. Basic Measurement and Analysis Techniques:

a. Noise.

(1) Measurement: Missile noise levels were recorded on Ampex 434 low noise tape and analyzed in the laboratory to obtain one-third octave band sound pressure levels as a function of time. A 114 decibel (dB), 1000 Hertz (Hz) calibration tone was recorded prior to and following the actual noise measurements. The frequency distribution (1/3 octave bands) of peak noise levels was also determined. Overall sound pressure levels were calculated from the 1/3 octave band data and presented as a function of time. A block diagram showing the measurement equipment set up is presented in Figure 2.

(2) Analysis: The taped data were analyzed using a real time noise and vibration analysis system. The 114 dB, 1000 Hz, calibration tone recorded on each tape was used as a reference level for analysis of the taped noise. A frequency response curve for each recording and playback system was also developed to align data output during analysis in the laboratory. The recording and analysis systems accuracy was determined by a simplified uncertainty analysis (see Appendix A) and the uncertainty (limit of error) in the resulting data was ± 1.9 dB. A block diagram of the noise analysis system is shown in Figure 3.

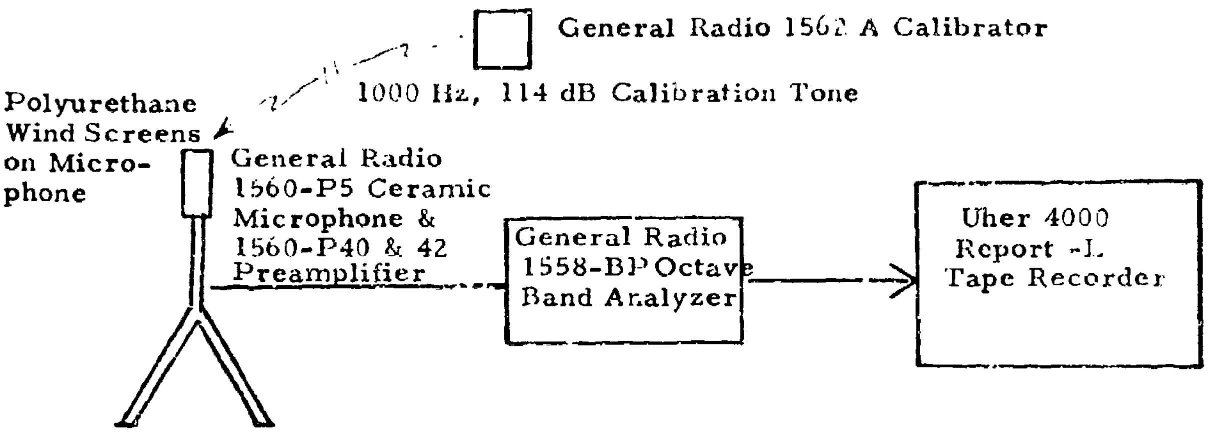
b. Vibration:

(1) Measurement: Two vibration pickups (accelerometers) were placed on a roof beam appearing to have the longest unsupported length. Vibration data (acceleration) were recorded on a dual channel tape recorder. The taped data were analyzed in the laboratory to obtain acceleration and frequency distribution data. Figure 4 shows a block diagram of the vibration measurement system.

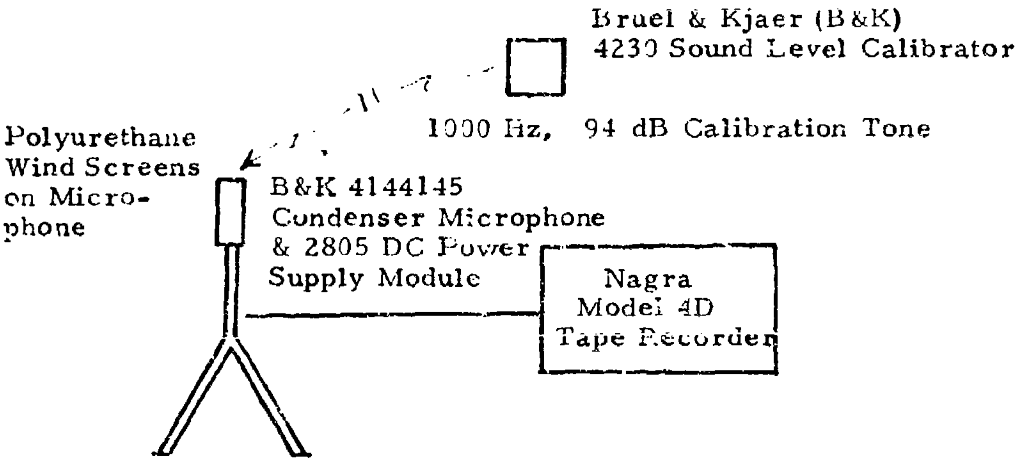
(2) Analysis: The taped data were analyzed using the real time noise and vibration analysis system. A one g (g = acceleration of gravity), 100 Hz, calibration signal was recorded on the tape to be used as a reference signal during analysis of the taped vibration data. A frequency response curve for each measurement and playback channel was also developed to align the data output during analysis. The vibration analysis system was identical to that used for noise analysis (Figure 3).

FIGURE 2

NOISE MEASUREMENT SYSTEMS



This system used for all sites except Tranquillon Peak



This system was used at Tranquillon Peak

FIGURE 3

NOISE ANALYSIS SYSTEM

Note: Only the noise data taped at Tranquillon Peak were played back for analysis with the Nagra recorder. The other tapes were played back with the Ampex AG-350.

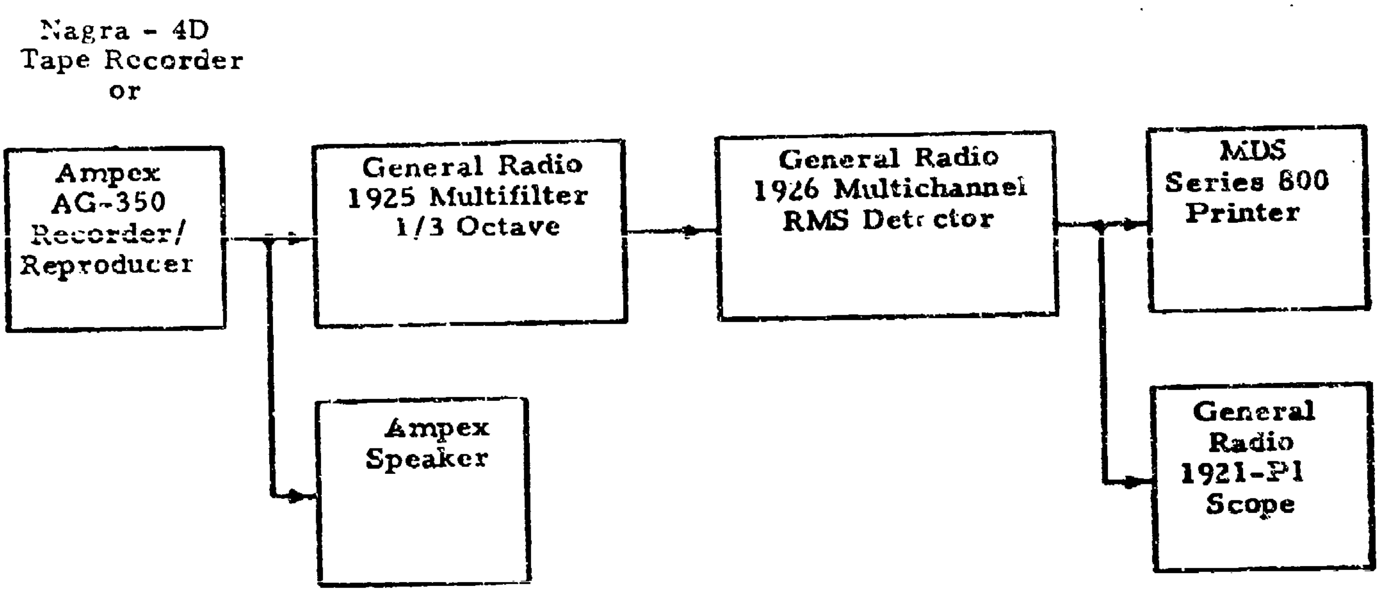
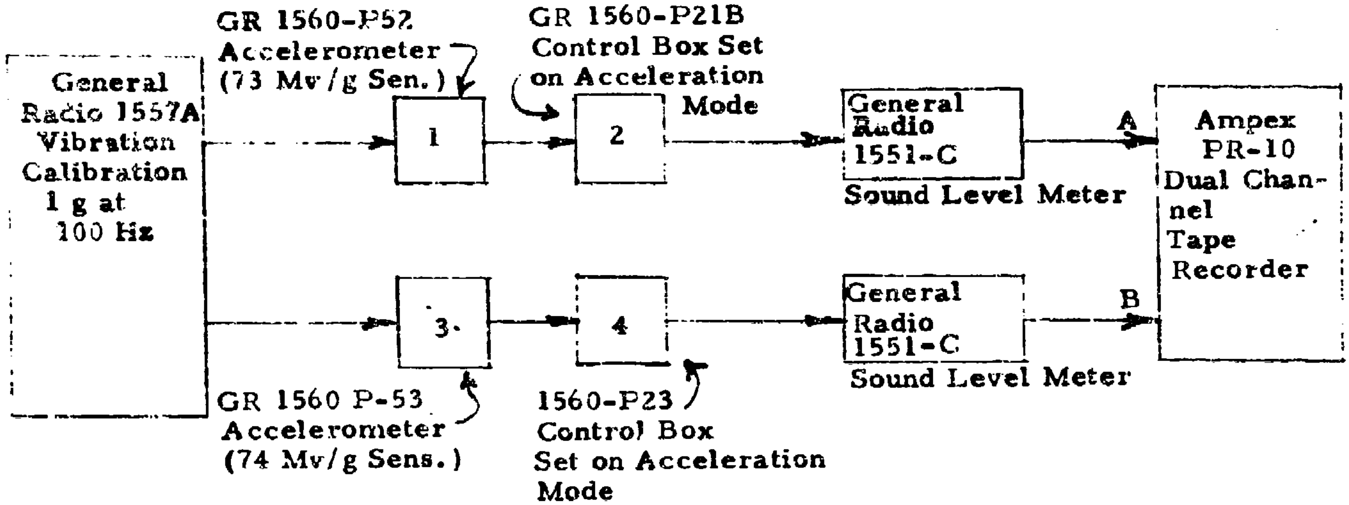


FIGURE 4

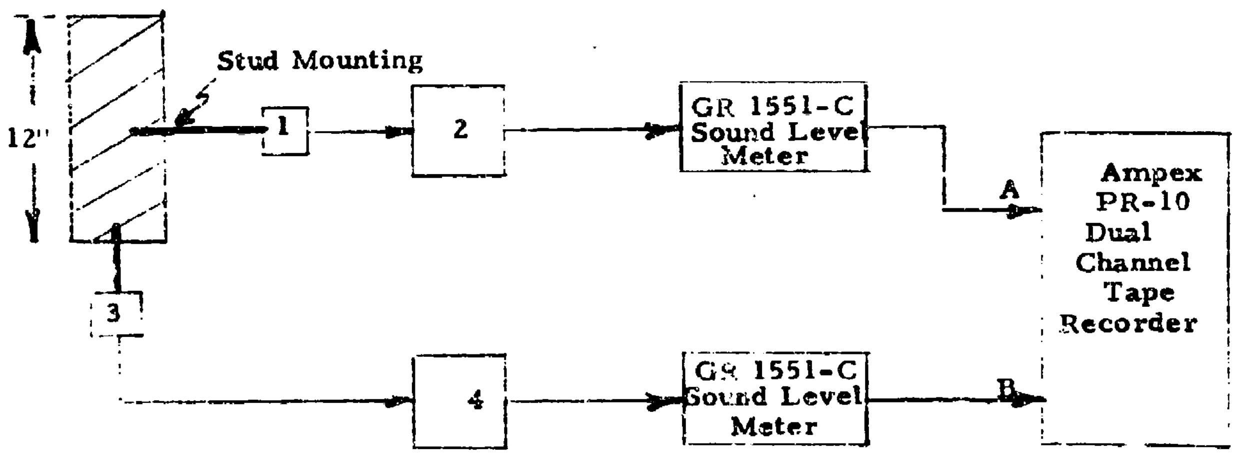
VIBRATION MEASUREMENTS

Calibration



Measurement

2" x 12" Beam Cross Section



A = Channel A

B = Channel B

SECTION III

DISCUSSION AND RESULTS

1. General: The predominantly low frequency noise, characteristic of rocket engines, was difficult to measure and analyze with the laboratory's noise analysis systems which are normally used for a frequency range of 25 Hz to 10 KHz. However, by recording the noise levels at 7 1/2 inches/second (ips) and playing them back at 15 ips, which essentially doubled the frequency of the recorded noise, it was possible to obtain 1/3 octave band sound pressure level data from 15.75 Hz to 8 KHz. The vibration data were limited by the frequency characteristics of the measuring equipment to a range of 25 Hz to 2 KHz. These equipment limitations, the lack of experience of laboratory personnel in measuring and evaluating vibration, coupled with a lack of existing vibration criteria specifying some level at which structural damage might be expected to occur, severely limits the confidence which can be placed upon the vibration data and their interpretation.

2. Noise:

a. One-third octave band and overall sound pressure levels: These data are presented as a function of time in Tables II thru V. Since the exact noise levels occurring at each site were not precisely known prior to the launch it was necessary to adjust the sound level measuring and recording equipment such that expected peak levels would not overdrive the instrumentation and saturate the tapes. This procedure increased the noise floor of the measurement instrumentation. Therefore, the lower noise levels measured in the high frequencies and during the first and last seconds of the launch may represent inherent instrumentation noise rather than actual ambient noise levels. Where this was clearly the case the levels in the Tables are identified by less than or equal signs (≤). The values presented in the Tables are root mean squared (RMS) sound pressure levels over a sample time of 7.6 seconds (8 seconds at Tranquillon Peak site). Although the real time analysis system is capable of integrating noise data in each frequency band every 1/8 seconds, the data printer associated with the system cannot assimilate the data this rapidly; therefore, a 4.0 second integration time was used. This is equivalent to 3.8 seconds actual launch time because there is a slight difference between the record speed of the Uher field recorder and the playback speed of the Ampex laboratory reproduction system. Thus, at 15 ips playback speed, 7.6 seconds of actual range time elapsed during the 4 second data integration period. The Tranquillon Peak data were played back with the

TABLE II

SLC-3 BLOCKHOUSE
SOUND PRESSURE LEVELS AND FREQUENCY DIS
AS A FUNCTION OF TIME

1/3 OCTAVE BAND (Hz) LEVELS (dB re 20

Time (Sec)	15.75	20	25	31.5	40	50	63	80	100	125	160	200	250	315	400	500	630	800	1.0k	1.
0	86	83	78	76	76	74	72	68	67	68	69	77	65	71	≤65	≤65	≤65	≤65	≤ 65	≤
7.7	102	105	107	107	106	103	105	101	96	93	93	92	87	88	89	90	88	89	88	
15.4	112	113	116	116	116	114	113	110	108	106	104	101	100	101	102	101	98	98	96	
23.1	115	112	114	113	112	112	112	111	106	101	101	103	103	103	99	97	96	95	94	
30.1	105	105	109	110	109	107	106	103	96	98	100	101	98	94	94	93	90	90	89	
38.5	99	103	106	104	99	97	93	88	88	93	93	93	85	88	86	85	83	83	82	
46.2	97	97	99	98	96	90	85	82	85	90	90	88	80	86	80	81	77	74	71	
53.9	92	91	92	92	90	82	82	79	77	81	86	85	83	76	80	73	74	70	67	≤
61.5	90	88	86	85	84	76	73	71	73	76	74	77	68	73	≤65	≤65	≤65	≤65	≤ 65	
69.2	87	82	83	81	80	75	76	72	71	71	71	78	65	72						
76.9	84	78	80	76	76	73	73	71	71	73	71	77		72						
84.6	82	76	74	75	72	72	69	68	68	69	69	77		71						
92.3	80	79	77	76	74	74	73	71	70	70	70	77		71						
Back Ground	67	64	61	57	55	51	55	58	58	64	53	47	53	44	38	42	41	42	42	

TABLE II

SLC-3 BLOCKHOUSE
SSURE LEVELS AND FREQUENCY DISTRIBUTION
AS A FUNCTION OF TIME

CTAVE BAND (Hz) LEVELS (dB re 20 $\mu N/m^2$)

200	250	315	400	500	630	800	1.0k	1.25k	1.6k	2.0k	2.5k	3.15k	4.0k	5.0k	6.3k	8.0k	Overall SPL
77	65	71	≦65	≦65	≦65	≦65	≦ 65	≦ 65	≦65	≦65	≦ 65	≦ 65	≦ 65	≦ 65	≦ 65	≦65	90
92	87	88	89	90	88	89	88	87	79	76	72	68	68	68	70	70	114
101	100	101	102	101	98	98	96	95	92	92	90	89	89	89	84	81	124
103	103	103	99	97	96	95	94	92	91	89	88	86	84	81	79	78	122
101	98	94	94	93	90	90	89	88	86	84	83	81	80	76	73	80	117
93	85	88	86	85	83	83	82	79	78	76	74	71	69	69	70	70	111
88	80	86	80	81	77	74	71	68	68	67	65	65	66	67	70	70	105
85	83	76	80	73	74	70	67	≤65	≤65	≤65	≤65	≤65	≤65	≤65	≤65	≤65	99
77	68	73	≤65	≤65	≤65	≤65	≤ 65						≤66	≤67	70		95
78	65	72															91
77		72															88
77		71															86
77		71															87
47	53	44	38	42	41	42	42	42	39	39	37	34	34	30	29	28	72

TABLE III

RANGE OPERATIONS (BLD

SOUND PRESSURE LEVELS AND FREQUENCY D
AS A FUNCTION OF TIME

1/3 OCTAVE BAND (Hz) LEVELS (dB re 20μ

[illegible]	15.75	20	25	31.5	40	50	63	80	100	125	160	200	250	315	400	500	630	800	1.0K
0	76	73	70	70	63	63	65	58	59	≤60	≤60	≤58	≤60	≤64	≤60	≤59	≤59	≤60	≤61
7.6	80	78	74	60	64	69	72	61	62	61	63	62	61	≤64	60	60	≤59	≤60	≤61
15.2	91	93	86	78	88	94	99	92	93	91	89	86	84	85	84	80	78	78	77
22.9	107	106	103	90	105	110	111	99	101	101	99	94	94	94	92	90	88	88	87
30.5	113	112	105	93	107	112	114	106	102	106	103	98	97	93	94	93	92	91	89
37.0	115	112	106	95	104	109	111	103	101	103	96	94	97	99	98	93	90	90	88
45.7	108	106	102	93	99	103	107	99	92	92	88	94	97	94	86	87	87	85	85
53.3	106	102	100	92	95	102	106	97	88	85	92	93	94	89	88	87	83	82	80
60.9	101	98	98	89	90	97	100	91	86	85	94	92	92	85	87	82	80	75	73
68.6	99	96	94	86	87	92	94	86	80	80	87	85	81	76	76	70	67	64	≤62
76.2	97	94	91	84	85	88	88	80	73	78	80	80	74	72	72	65	63	≤60	≤61
83.8	94	91	87	79	84	83	85	77	71	74	75	73	68	66	64	60	≤59	≤59	≤60
91.4	91	89	85	80	83	83	84	76	70	75	76	74	71	65	63	≤59		≤60	≤60
99.1	89	87	85	78	82	82	83	77		72	74	72	69	65	61			≤60	≤60
106.7	89	85	83	77	81	80	82	75		72	75	74	72	≤64	≤60			≤60	≤60
114.3	85	83	84	76	80	78	81	72		70	72	69	67	≤64	≤60			≤60	≤61
121.9	85	84	85	76	80	79	82	72		72	74	72	69	≤64	≤60			≤59	≤60
129.5	83	85	82	75	78	77	79	70		70	71	68	66	≤64	≤61			≤60	≤61
138.5	81	84	81	73	77	75	76	67	64	65	68	66	63	≤63	≤60				≤61
144.8	83	79	80	72	75	74	75	65	64	63	65	64	62	≤63	≤60	≤58			≤61
152.4	79	79	79	70	73	74	74	64	64	61	64	62	62	≤63	≤60	≤59			≤60
160.0	73	77	76	70	72	71	72	61	61	61	62	62	≤61	≤64	≤59	≤60			≤61
167.6	76	76	76	70	72	72	72	63	62	61	63	62	≤61	≤63	≤60	≤59			≤60
175.2	78	76	76	70	72	74	72	63	63	≤60	62	62	≤61	≤64	≤59	≤58			
182.9	76	76	78	72	72	73	71	63	62	≤60	≤61	≤59	≤60	≤63	≤59	≤58			
190.5	75	75	76	71	71	74	72	63	64	≤62	≤61	≤61	≤61	≤64	≤60	≤59			
198.1	74	71	73	64	69	73	70	60	64	≤63	≤60	≤60	≤61	≤64	≤60	≤58	≤58		
205.7	76	75	77	68	78	71	70	62	61	≤60	≤60	≤61	≤60	≤63	≤59	≤59	≤59		
213.3	71	71	72	66	67	68	70	61	60	≤60	≤60	≤58	≤60	≤63	≤59	≤58	≤59	≤59	
Back Ground	78	74	74	63	64	63	62	53	51	51	46	44	44	42	41	40	39	40	41

TABLE III

RANGE OPERATIONS (BLDG 488)

JRE LEVELS AND FREQUENCY DISTRIBUTION
AS A FUNCTION OF TIME

VE BAND (Hz) LEVELS (dB re $20\mu N/m^2$)

0	250	315	400	500	630	800	1.0k	1.25k	1.6k	2.0k	2.5k	3.15k	4.0k	5.0k	6.3k	8.0k	Overall SPL
8	≤60	≤64	≤60	≤59	≤59	≤60	≤61	≤61	≤62	≤63	≤65	≤64	≤65	≤66	≤64	≤63	81
2	61	≤64	60	60	≤59	≤60	≤61	≤62	≤62	≤63	≤65	≤65	≤65	≤65	≤65		84
6	84	85	84	80	78	78	77	73	71	67	≤65	≤65	≤64	≤65	≤65		103
4	94	94	92	90	88	88	87	85	82	80	78	74	68	67	≤65		116
8	97	93	94	93	92	91	89	88	86	84	83	78	74	71	68	≤65	120
4	97	99	98	93	90	90	88	86	87	85	84	80	76	71	68	≤64	119
4	97	94	86	87	87	85	85	84	81	80	78	74	71	68	≤65	≤63	113
3	94	89	88	87	83	82	80	78	77	74	72	66	≤66	≤66	≤64		111
2	92	85	87	82	80	75	73	71	71	71	70	67	≤65	≤65	≤64		107
5	81	76	76	70	67	64	≤62	≤62	≤62	≤63	≤65	≤64			≤64		103
0	74	72	72	65	63	≤60	≤61	≤61	≤62			≤65			≤65		100
3	68	66	64	60	≤59	≤59	≤60	≤61	≤62			≤64			≤64		97
4	71	65	63	≤59		≤60	≤60	≤61	≤61						≤64		95
2	69	65	61			≤60	≤60	≤61	≤61						≤64	≤62	94
4	72	≤64	≤60			≤60	≤60	≤61	≤62		≤64				≤64	≤63	93
9	67	≤64	≤60			≤60	≤61	≤62	≤62		≤65		≤64		≤63	≤62	91
2	69	≤64	≤60			≤59	≤60	≤61	≤62				≤65		≤64	≤62	92
8	66	≤64	≤61			≤60	≤61	≤61	≤62	≤64			≤64	≤64	≤63	≤61	90
6	63	≤63	≤60				≤61	≤61	≤62	≤63			≤64	≤65	≤63	≤62	88
4	62	≤63	≤60	≤58			≤61	≤61	≤61				≤65	≤64		≤61	87
2	62	≤63	≤60	≤59			≤60	≤62	≤62				≤64	≤65		≤62	86
2	≤61	≤64	≤59	≤60			≤61	≤61	≤62					≤64		≤61	83
2	≤61	≤63	≤60	≤59			≤60		≤62		≤64	≤65		≤65			83
2	≤61	≤64	≤59	≤58					≤61		≤65	≤64	≤65	≤65			84
9	≤60	≤63	≤59	≤58					≤61		≤64		≤64	≤64		≤62	84
1	≤61	≤64	≤60	≤59					≤62							≤61	83
0	≤61	≤64	≤60	≤58	≤58				≤62							≤62	81
1	≤60	≤63	≤59	≤59	≤59				≤62							≤61	83
8	≤60	≤63	≤59	≤58	≤59	≤59			≤61						≤62	≤61	80
4	44	42	41	40	39	40	41	42	42	44	45	45	45	46	44	42	81

TABLE IV

TRANQUILLON PEAK

SOUND PRESSURE LEVELS AND FREQUENCY D
AS A FUNCTION OF TIME

1/3 OCTAVE BAND (Hz) LEVELS (dB re 20 µ

[illegible]	[illegible]	20	25	31.5	40	50	63	80	100	125	160	200	250	315	400	500	630	800	1.0k	1.
0	69	67	65	60	58	57	57	56	55	53	50	≤63	≤55	≤57	≤52	≤50	≤50	≤51	≤52	≤
8	68	66	60	60	56	55	54	52	53	52	50	≤62	≤54	≤57	≤53	≤51	≤50	≤51	≤52	≤
16	74	74	74	74	72	73	70	70	69	68	69	65	61	61	60	60	57	54	≤53	≤
24	88	90	90	93	94	94	92	92	91	90	89	85	83	81	78	77	75	71	68	
32	99	100	99	102	102	100	99	100	100	96	96	91	87	87	84	83	81	76	73	
40	95	95	95	96	99	96	94	95	94	90	88	85	84	84	83	81	78	78	75	
48	100	100	98	100	102	99	99	99	96	91	89	89	90	91	86	83	85	82	82	
56	104	103	101	101	102	99	98	95	95	89	92	94	95	90	87	86	84	84	83	
64	99	100	98	99	98	94	93	92	88	84	90	89	88	81	84	80	78	77	75	
72	97	97	96	96	93	92	91	87	82	82	87	85	82	78	81	75	74	72	70	
80	93	94	94	91	91	90	87	83	80	81	85	81	78	76	75	71	68	62	59	
88	92	93	90	88	89	88	83	79	77	78	81	76	73	72	72	67	62	57	56	≤
96	91	92	88	88	87	86	83	78	76	78	80	75	70	69	69	61	56	53	≤52	≤
104	89	89	84	86	83	80	76	73	73	76	71	68	66	65	64	59	53	≤51		≤
112	87	86	84	85	83	81	77	74	72	72	76	71	69	64	65	58	53			
120	87	82	82	82	81	78	74	73	69	68	70	67	60	59	56	52	≤50			
128	85	83	82	81	80	79	74	71	69	68	72	68	64	60	58		≤50			≤
136	87	84	82	82	80	77	73	72	67	67	71	84	62	59	57		≤51	≤50		≤
144	85	82	79	81	78	74	71	70	67	63	67	66	60	58	54	≤51	≤50	≤51		≤
152	83	80	77	78	76	73	72	69	66	62	66	65	60	58	55	≤51	≤50	≤50		
160	82	78	75	77	76	73	72	67	66	60	62	≤63	≤67	≤57	≤53	≤50	≤49	≤51		
168	82	78	75	76	75	70	67	64	62	60	60				≤53	≤51	≤50			
176	78	78	73	75	73	71	68	67	62	60	62				≤54	≤50	≤50			
184	79	77	75	76	75	71	68	66	60	57	58	≤62			≤53	≤50	≤49	≤50		≤
192	80	75	73	75	72	70	68	66	61	59	60	≤63	≤58	≤58		≤51	≤50	≤50		
200	77	74	70	73	70	64	62	62	61	59	58	≤63	≤56	≤57		≤51	≤50	≤51		
208	77	74	70	73	72	68	66	61	56	54	52	≤62	≤55			≤50	≤50	≤51		≤
216	77	74	70	73	70	69	66	59	58	55	54	≤61	≤55			≤50	≤50	≤50		≤
Back Ground	70	71	63	62	61	60	60	53	51	51	49	49	49	49	48	47	47	47	48	

TABLE IV

TRANQUILLON PEAK

ESSURE LEVELS AND FREQUENCY DISTRIBUTION AS A FUNCTION OF TIME

TAVE BAND (Hz) LEVELS (dB re 20 $\mu N/m^2$)

200	250	315	400	500	630	800	1.0k	1.25k	1.6k	2.0k	2.5k	3.15k	4.0k	5.0k	6.3k	8.0k	Overall SPL
≤63	≤55	≤57	≤52	≤50	≤50	≤51	≤52	≤52	≤55	≤55	≤54	≤56	≤56	≤57	≤57	≤60	74
≤62	≤54	≤57	≤53	≤51	≤50	≤51	≤52	≤52	≤55	≤55			≤57		≤57		73
65	61	61	60	60	57	54	≤53	≤53	≤55	≤54			≤56		≤58		83
85	83	81	78	77	75	71	68	62	60	≤55			≤57			≤61	102
91	87	87	84	83	81	76	73	68	65	59			≤57	≤58		≤61	110
85	84	84	83	81	78	78	75	72	68	66	60	58	≤57	≤57		≤60	106
89	90	91	86	83	85	82	82	79	77	75	71	67	65	61		≤61	109
94	95	90	87	86	84	84	83	79	77	79	74	68	71	62	≤59		111
89	88	81	84	80	78	77	75	73	68	66	61	60	≤58	≤58	≤58		107
85	82	78	81	75	74	72	70	68	65	60	≤55	≤57	≤57	≤57		≤60	104
81	78	76	75	71	68	62	59	55	57	≤55	≤54	≤55	≤56			≤60	101
76	73	72	72	67	62	57	56	≤53	≤55	≤55		≤56	≤57			≤61	99
75	70	69	69	61	56	53	≤52	≤53		≤54					≤57	≤60	97
68	66	65	64	59	53	≤51		≤52							≤58	≤61	94
71	69	64	65	58	53										≤58	≤60	93
67	60	59	56	52	≤50					≤55			≤56		≤57		91
68	64	60	58		≤50			≤53		≤54					≤58		90
84	62	59	57		≤51	≤50		≤53							≤57		92
66	60	58	54	≤51	≤50	≤51		≤52							≤58		89
65	60	58	55	≤51	≤50	≤50					≤55	≤55	≤57		≤57		87
≤63	≤57	≤57	≤53	≤50	≤49	≤51					≤54	≤56			≤58		86
			≤53	≤51	≤50					≤55	≤54				≤57		85
			≤54	≤50	≤50					≤54	≤53				≤58		84
≤62			≤53	≤50	≤49	≤50		≤53			≤54	≤55	≤56		≤57		84
≤63	≤58	≤58		≤51	≤50	≤50						≤56	≤56		≤58		84
≤63	≤56	≤57		≤51	≤50	≤51							≤57		≤57		81
≤62	≤55			≤50	≤50	≤51		≤52	≤54	≤55			≤56	≤58	≤58		82
≤61	≤55			≤50	≤50	≤50		≤52	≤55	≤54		≤56	≤57	≤57	≤58		81
49	49	49	48	47	47	47	48	48	48	47	47	47	47	48	47	46	75

TABLE V

OAK MOUNTAIN

SOUND PRESSURE LEVELS AND FREQUENCY D

AS A FUNCTION OF TIME

1/3 OCTAVE BAND (Hz) LEVELS (dB re 20

Time (sec)	15.75	20	25	31.5	40	50	63	80	100	125	160	200	250	315	400	500	630	800	1.0k	1
0	70	65	61	62	59	63	59	56	55	58	54	51	50	57	48	≤47	≤47	≤47	≤ 47	≤
7.7	72	67	63	63	61	63	60	59	59	60	57	54	51	57	49			≤48		≤
15.4	71	68	64	64	62	64	62	61	59	60	56	54	51	58	49			≤47		≤
23.1	79	78	72	73	69	67	62	59	56	57	55	50	49	56	48		≤46		≤46	≤
30.8	82	78	74	74	70	69	63	61	58	60	56	53	50	58	49	≤48	≤47		≤47	≤
38.5	76	74	73	73	76	75	72	74	74	72	69	69	63	61	55	52	50	≤48	≤47	
46.2	85	80	80	83	86	85	84	86	85	82	80	77	73	69	63	61	60	56	51	
53.9	95	95	95	96	97	96	95	95	93	91	89	86	81	77	72	69	66	63	58	
61.5	93	91	91	95	95	97	96	96	95	93	91	88	83	79	75	73	71	68	63	
69.2	92	90	92	95	95	93	93	92	89	87	85	81	76	78	78	78	75	68	67	
76.9	100	100	98	101	100	98	96	94	93	90	87	81	81	85	86	84	80	74	74	
84.6	99	96	98	100	99	97	96	93	89	87	81	82	84	87	84	77	77	74	72	
92.3	97	96	95	98	97	95	92	89	86	81	80	82	83	83	77	74	74	68	66	
100.0	93	95	93	96	94	93	90	86	81	75	77	79	78	76	66	68	64	61	53	
107.7	94	92	90	93	92	91	88	84	77	74	75	78	77	72	64	64	56	54	49	≤
115.4	95	95	92	90	92	91	90	87	83	75	74	77	80	77	70	64	53	50	≤48	
123.1	93	91	88	89	89	87	85	80	73	72	76	78	74	66	66	59	53	≤48	≤47	
130.8	90	91	87	89	87	86	83	77	70	72	75	76	71	63	64	54	51	≤49	≤51	
138.5	89	88	86	84	84	83	80	75	70	71	73	74	69	61	60	53	49	≤47	≤47	
146.2	90	88	84	84	82	81	79	75	68	71	71	72	67	59	56	51	≤48	≤48		
153.9	87	85	83	82	80	79	77	73	66	69	70	71	65	60	58	51	≤48	≤47		≤
161.5	85	82	79	80	77	75	74	72	65	67	68	68	62	58	56	49	≤47			≤
169.2	86	83	81	81	79	76	75	72	67	66	69	69	64	58	53	≤48				≤
176.9	87	84	80	82	80	76	75	73	67	65	67	68	62	57	53	≤48				≤
Back Ground	83	81	73	76	71	65	62	60	58	57	49	46	43	43	41	40	40	40	40	

TABLE V

OAK MOUNTAIN

SURE LEVELS AND FREQUENCY DISTRIBUTION
AS A FUNCTION OF TIME

AVE BAND (Hz) LEVELS (dB re 20 $\mu N/m^2$)

0	250	315	400	500	630	800	1.0k	1.25k	1.6k	2.0k	2.5k	3.15k	4.0k	5.0k	6.3k	8.0k	Overall SPL
1	50	57	48	≤47	≤47	≤47	≤47	≤47	≤47	≤47	≤48	≤51	≤51	≤52	≤54	≤58	74
4	51	57	49			≤48		≤48	≤48	≤48	≤49	≤50					75
4	51	58	49			≤47		≤48	≤48	≤47	≤49	≤51					75
)	49	56	48		≤46		≤46	≤47	≤47	≤47	≤48	≤50			≤53	≤57	83
3	50	58	49	≤48	≤47		≤47	≤48	≤48	≤48	≤49	≤51			≤54	≤58	85
9	63	61	55	52	50	≤48	≤47			≤47						≤57	85
7	73	69	63	61	60	56	51			≤47				≤53		≤58	94
,	81	77	72	69	66	63	58	53	≤49	≤48				≤52			105
3	83	79	75	73	71	68	63	58	53	≤48				≤53			105
	76	78	78	78	75	68	67	63	59	54	≤50		≤52	≤52			102
	81	85	86	84	80	74	74	68	65	60	56	54	≤52	≤53			108
	84	87	84	77	77	74	72	68	63	58	54	52	≤51	≤52		≤59	107
	83	83	77	74	74	68	66	65	56	50	≤49	≤51				≤58	105
	78	76	66	68	64	61	53	50	≤48	≤47							102
	77	72	64	64	56	54	49	≤48									100
	80	77	70	64	53	50	≤48					≤50					101
	74	66	66	59	53	≤48	≤47					≤51					98
	71	63	64	54	51	≤49	≤51			≤48	≤48	≤50					97
	69	61	60	53	49	≤47	≤47			≤47	≤49	≤51		≤53			94
	67	59	56	51	≤48	≤48				≤48		≤50		≤52			94
	65	60	58	51	≤48	≤47		≤47		≤47		≤50					92
	62	58	56	49	≤47			≤48	≤47		≤48	≤51					89
	64	58	53	≤48				≤47	≤48		≤49			≤53			90
	62	57	53	≤48				≤48	≤48		≤49			≤52		≤57	91
	43	43	41	40	40	40	40	40	40	40	40	40	40	40	40	40	86

field recorder (see Figure 2), thus record and reproduce tape speeds were the same. At this site a 4 second integration time was equal to an actual 4 seconds of launch or range time at 7 1/2 ips and 8 seconds of range time at 15 ips playback speed.

b. Peak Noise and Frequency Distribution: The time that peak noise levels occurred was determined from the overall levels presented in Tables II thru V. The tapes were then analyzed at that time using a 1/8 second integration time to obtain peak instantaneous noise levels and their frequency distribution. Figures 5 thru 8 present peak noise levels as a function of frequency (1/3 octave bands). The peak levels and frequency distribution are a little more accurate because the averaging time, i.e., integration time (1/8 second) was much shorter.

c. Comparison of Measured With Predicted Noise Levels: The noise levels measured were within the range predicted on the basis of Titan III C, D and E noise data provided by SAMSO/LVRO personnel (see Appendix B). Table VI shows measured and predicted noise levels at each measurement site.

TABLE VI

COMPARISON OF MEASURED & PREDICTED LEVELS

Location	Ground Distance From Launch Site ft)	Peak OSPL'S (dB) re $20 \mu N/m^2$ Predicted	Measured
SLC-3	8,400	124	124
Range Ops (Bldg 488)	16,200	118	120
Tranquillon Peak	24,000	114	111
Oak Mountain	44,000	107	108

These overall peak sound pressure levels are plotted as a function of distance in Figure 9 to facilitate extrapolation of these data to distances greater than measured. Since low frequency noise is difficult to attenuate, the use of existing data for application at different

FIGURE 5

SLC-3 BLOCKHOUSE
PEAK SOUND PRESSURE LEVELS

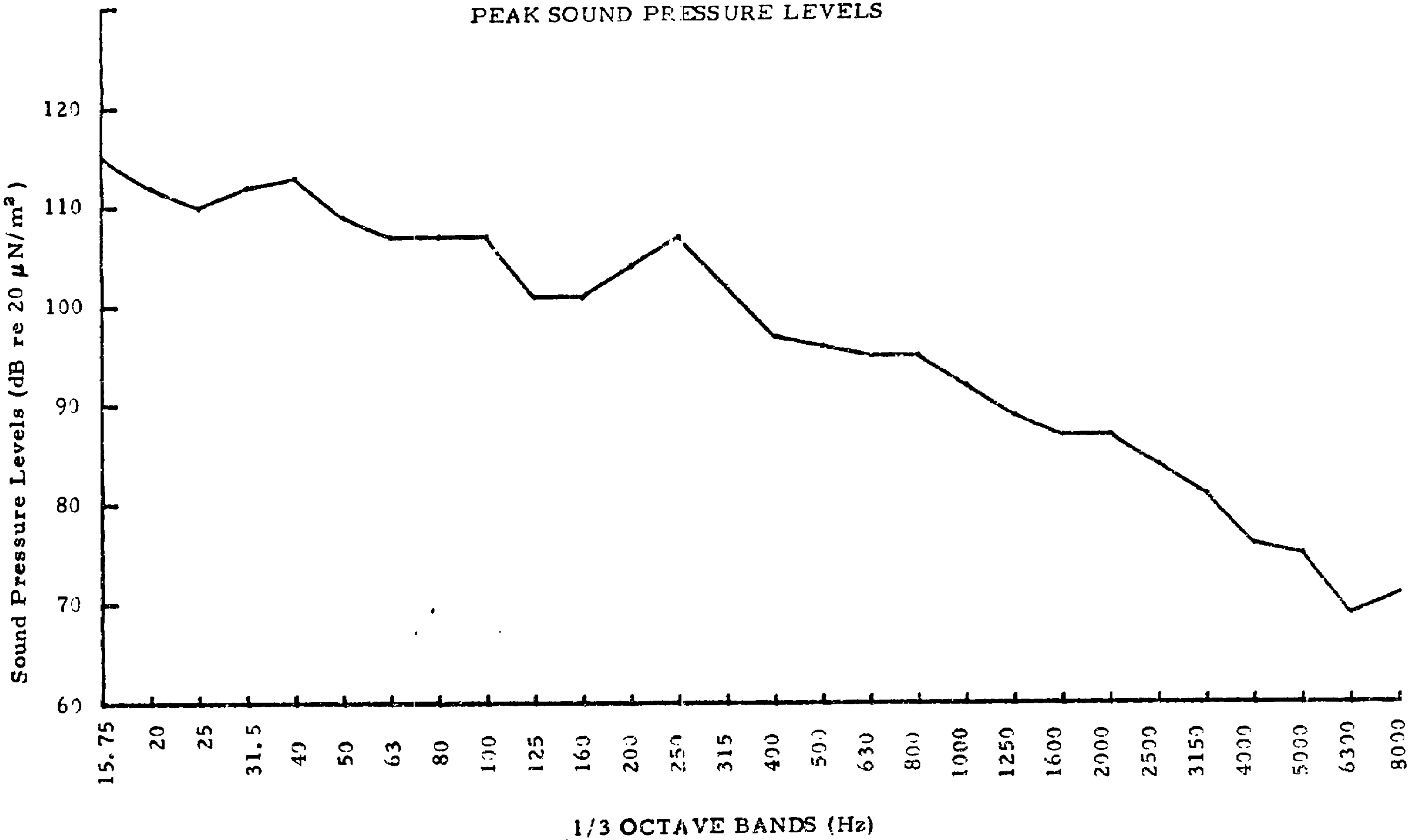


FIGURE 6

RANGE OPERATIONS
PEAK SOUND PRESSURE LEVELS

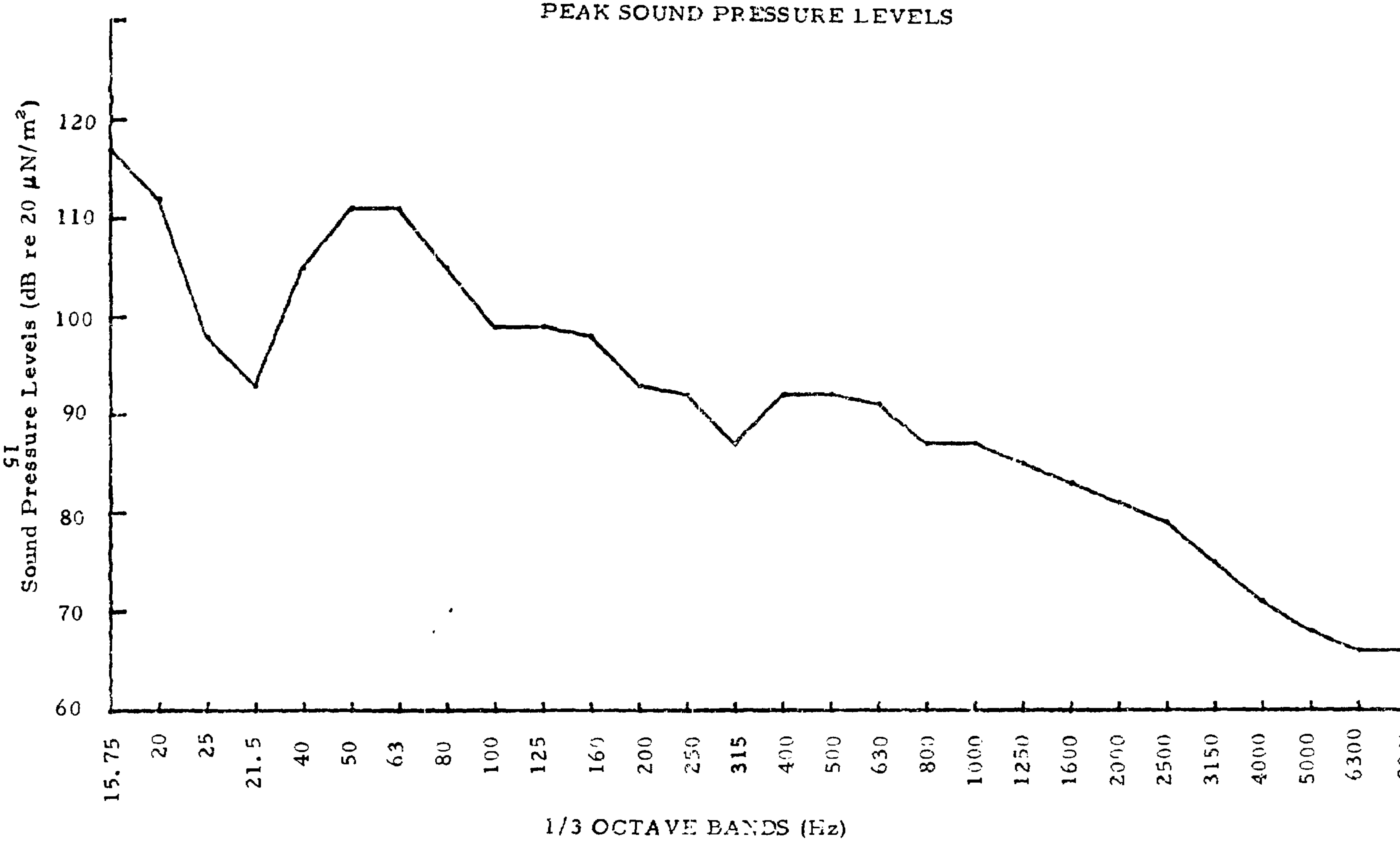


FIGURE 7

TRANQUILLON PEAK
PEAK SOUND PRESSURE LEVELS

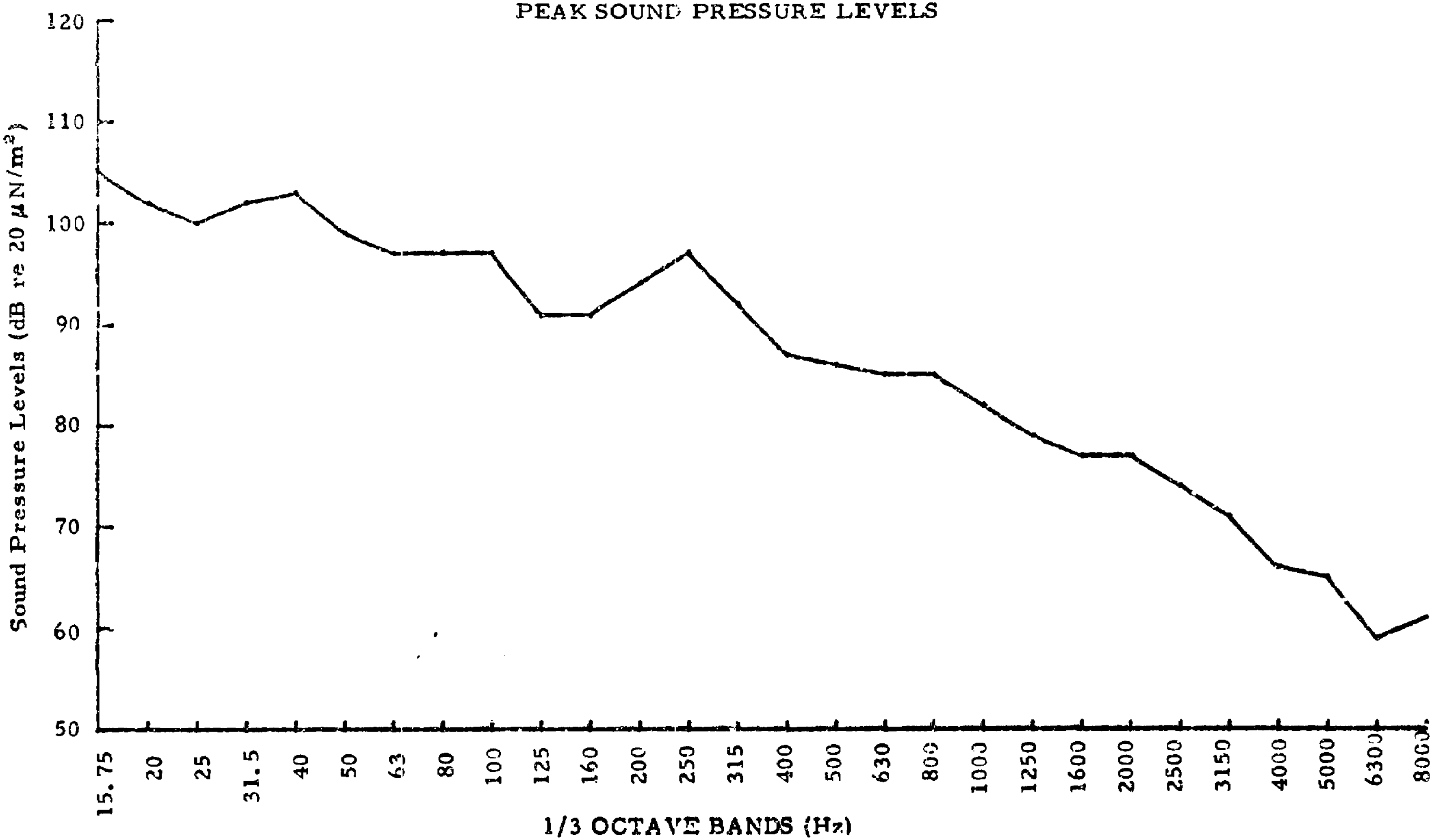


FIGURE 8

OAK MOUNTAIN
PEAK SOUND PRESSURE LEVELS

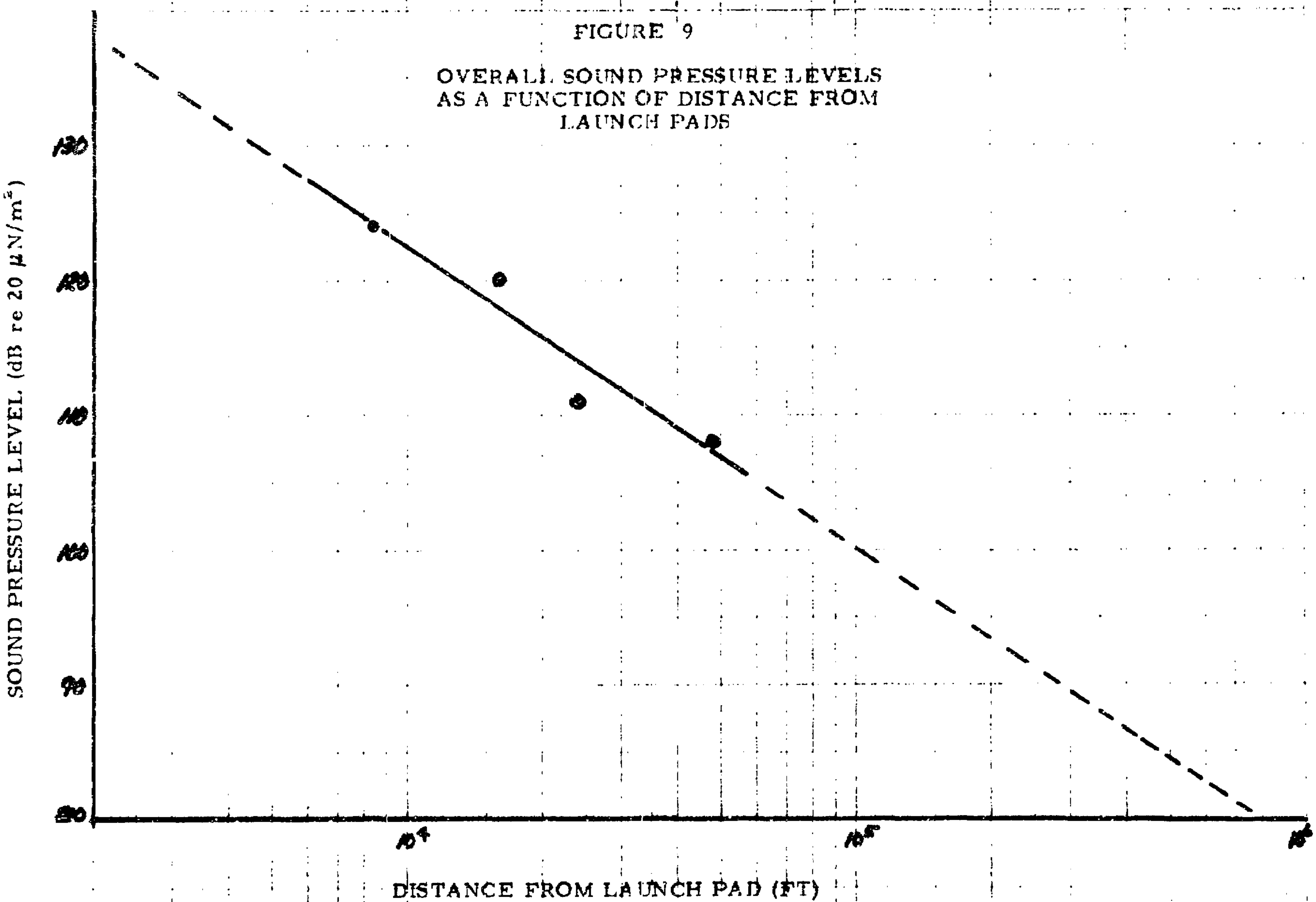


FIGURE 9

OVERALL SOUND PRESSURE LEVELS AS A FUNCTION OF DISTANCE FROM LAUNCH PADS

sites and under different weather conditions should result in reasonably accurate predictions. However, the weather data during the measurements are shown in Appendix C so that correction for sound attenuation by air can be applied, if desired, when extrapolating these data to different weather conditions.

d. Estimated Environmental Impact:

(1) The impact of any single noise event is difficult to determine when one is concerned about levels and exposure times below those normally considered hazardous to hearing; however, perceived noise levels (PNL's) and effective perceived noise levels (EPNL's) are commonly used to define single event noise levels, e.g., aircraft flyovers. The maximum PNL's calculated from 1/3 octave band data (50 Hz - 10,000 Hz) are shown in conjunction with exepcted responses or judgements of personnel exposed in Table VII (Ref. 1).

TABLE VII

MAXIMUM PNL'S AND EXPECTED RESPONSE

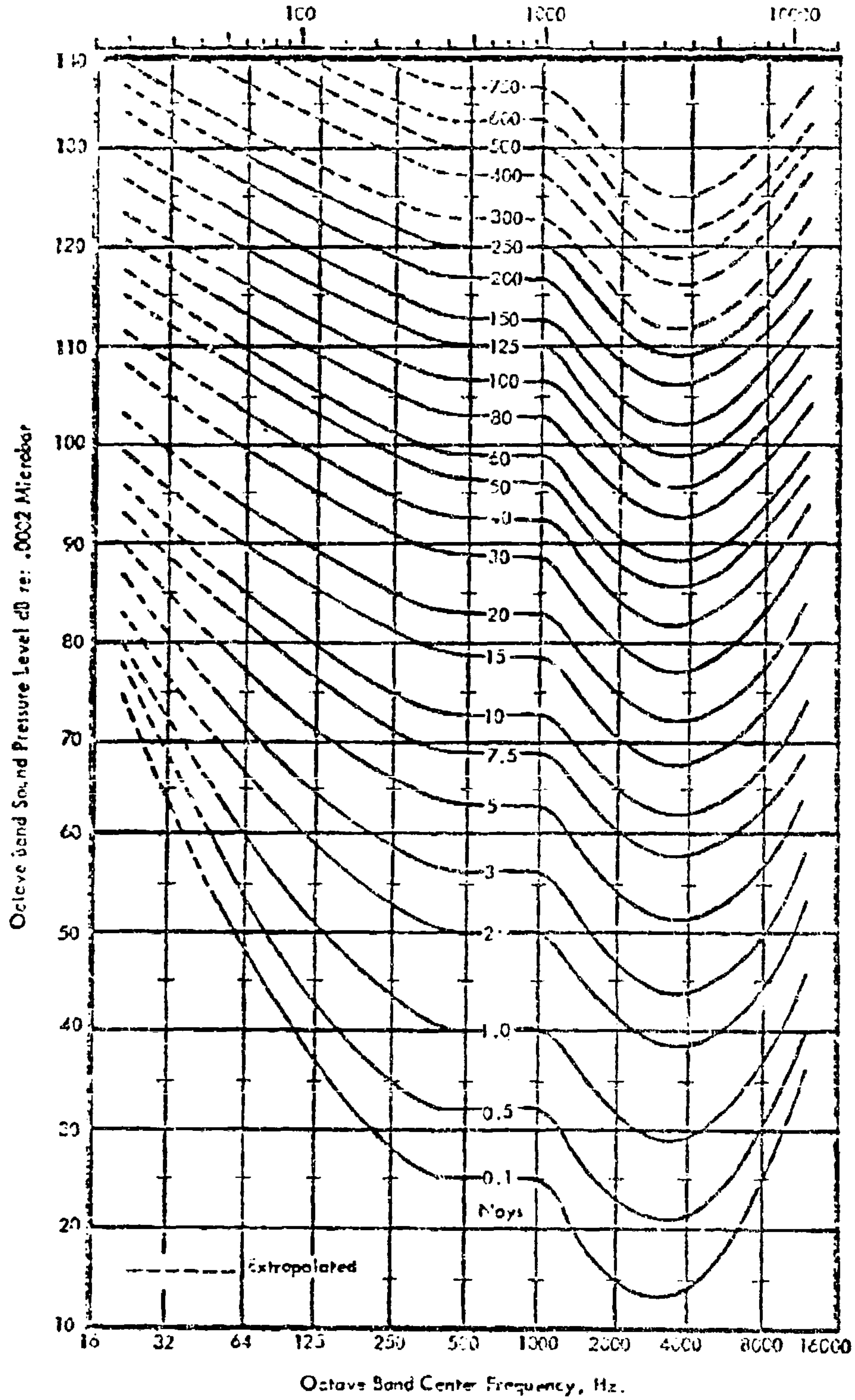
Location	Max. PNL (dB)	Ranges of Response
SLC-3	118	Unacceptable, annoying, noisy
Range Operations	114	
Tranquillon Peak	110	Unacceptable, intrusive, moderately noisy
Oak Mountain	105	Barely acceptable, intrusive, moderately noisy

The PNL is calculated from a subjective unit of noisiness called the "noy." A sound of two noy is said to be subjectively twice as noisy as a sound of one noy. Curves of equal noisiness, with sound pressure levels plotted as a function of frequency, are shown in Figure 10. Considerably higher sound pressure levels are required in the lower frequencies than in middle and high frequencies to produce a subjectively equal level of noisiness. The PNL is calculated from these type curves and is basically a translation of the subjective noy scale to a dB scale. Therefore, the

FIGURE 10

Subjective Reaction to Acoustic Noise

CURVES OF EQUAL NOISINESS



frequency or spectral characteristics of the noise significantly influence the value of the PNL calculated and may appear to be lower or higher than might be expected on the basis of overall sound pressure levels.

(2) The Noise Exposure Forcast (NEF) which is used to estimate community response to a series of noise events can be calculated from PNL's and EPNL's. The basic equations used for determination of EPNL and NEF are shown below:

$$EPNL = PNL + 10 \log \frac{t}{15}$$

where: PNL = maximum PNL calculated from 1/3 octave bands (50 Hz - 10,000 Hz) sound pressure levels

t = duration, in seconds, of noise within 10 dB of maximum PNL

$$NEF = EPNL + 10 \log \left(\frac{Nd}{20} + \frac{Nn}{1.2} \right) - 75$$

where: Nd = number of day operations (0700 - 2200 hrs)

Nn = number of night operations (2200 - 0700 hrs)

The NEF at each site was determined by assuming one Titan III D missile launch per day. This is probably an overestimate of activity. These NEF's are shown for each measurement site in Table VIII.

TABLE VIII

NEF'S AND ESTIMATED COMMUNITY RESPONSE

Location	Approximate NEF's	Estimated Community Impact (Ref. 1)
SLC-3	34	Individuals in private residences may complain vigorously.
Range Ops (Bldg 488)	30	Commercial use - OK
Tranquillon Peak	27	Satisfactory for all uses except possibly schools, churches, hospitals, etc.
Oak Mountain	23	

It should be realized that the NEF was developed primarily for aircraft noise after studying the reactions of large numbers of individuals to specific aircraft noises. Also, individual tolerance varies considerably as demonstrated by survey around London Heathrow Airport which determined that approximately 10 percent of the population were ultra-sensitive to noise and objected to any outside noise intrusion while 25 percent of the population were unaffected even by very high community noise levels (Ref. 1,2). Therefore, these two portions of the population (35%) will not be significantly affected by noise abatement efforts; only the remaining 65 percent of the population will be helped by noise control and characterizing the noise environment. Some of the important factors other than the actual noise environment which affect human response to noise intrusion include:

(a) Socioeconomic status

(b) Relative importance and necessity of noise source

(c) Relation of noise source to individual, i.e., an individual who is economically dependent on the noise source is less likely to be annoyed

(d Activity being done during noise exposure

(3) Acoustical damage to structures can be estimated from Figures 11 and 12. No damage is expected at distances greater than 24,000 ft.

3. Vibration:

a. Peak Vibration and Frequency Distributions (La Purisima Mission): Only the peak vibration (acceleration) levels were reported as other levels were not significantly above background. The peak vibration levels occurred essentially simultaneously with the peak noise levels, 92 - 100 seconds after launch, indicating that the vibration was induced by airborne noise. Thus, noise at this site would also be a satisfactory measurement parameter for damage estimation as there are single event noise criteria relating noise levels at various frequencies to structure damage (see Figures 11 & 12). Peak and background acceleration from 25 Hz to 2000 Hz (limiting frequencies of measurement equipment) are shown in Tables IX and X.

b. Effects on La Purisima Mission:

(1) Examination of the acceleration data indicates that peak values were only slightly above background and in some frequencies

FIGURE 11

ACOUSTICAL DAMAGE CRITERIA FOR WALLS

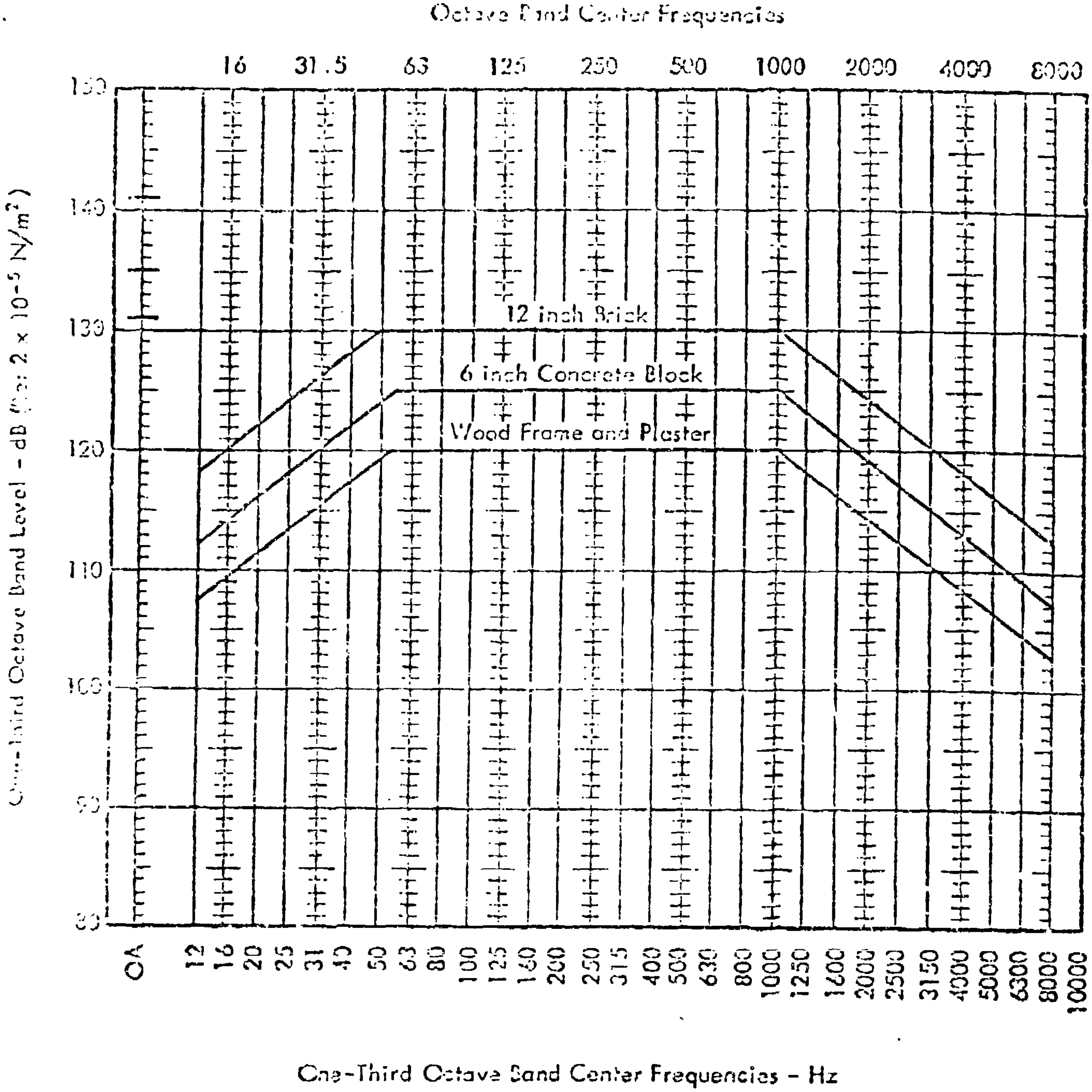


FIGURE 12

ACOUSTICAL DAMAGE CRITERIA FOR GLASS

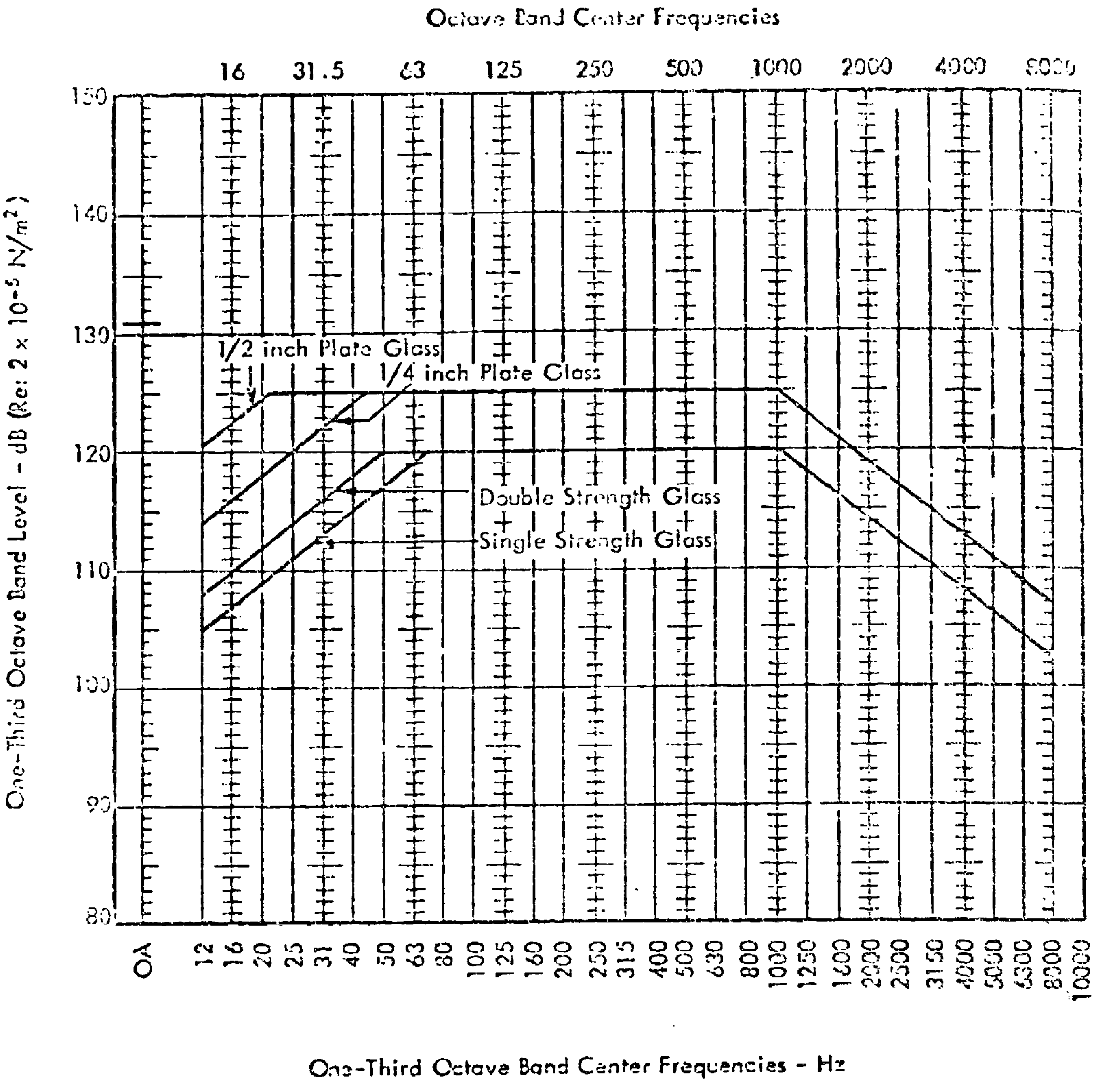


TABLE IX

VIBRATION DATA

ACCELEROMETER A

1/3 Octave Center Frequency (Hz)	Peak Acceleration (g's)	Background (g's)
2.0K	7.8×10^{-5}	1.4×10^{-4}
1.6K	9.8×10^{-5}	2.8×10^{-4}
1.25K	6.3×10^{-5}	1.6×10^{-4}
1.0K	5.7×10^{-5}	7.5×10^{-4}
800	4.9×10^{-5}	5.0×10^{-5}
630	4.5×10^{-5}	5.8×10^{-5}
500	5.8×10^{-5}	8.2×10^{-5}
400	1.5×10^{-4}	1.7×10^{-4}
315	1.5×10^{-4}	1.9×10^{-4}
250	1.8×10^{-4}	8.0×10^{-5}
200	3.8×10^{-4}	1.3×10^{-4}
160	1.6×10^{-3}	4.2×10^{-4}
125	4.1×10^{-3}	4.9×10^{-4}
100	6.7×10^{-4}	1.6×10^{-4}
80	5.3×10^{-4}	6.7×10^{-4}
63	2.2×10^{-3}	4.8×10^{-3}
50	1.1×10^{-3}	1.2×10^{-3}
40	2.0×10^{-4}	4.2×10^{-4}
31.5	2.1×10^{-4}	2.8×10^{-4}
25	4.0×10^{-4}	1.4×10^{-4}

TABLE X

VIBRATION DATA

ACCELEROMETER B

1/3 Octave Center Frequencies (Hz)	Peak Acceleration (g's)	Background (g's)
2.0K	2.9×10^{-4}	1.1×10^{-4}
1.6K	2.9×10^{-4}	1.4×10^{-4}
1.25K	2.9×10^{-4}	1.1×10^{-4}
1.0K	2.9×10^{-4}	1.0×10^{-4}
800	2.9×10^{-4}	9.2×10^{-5}
630	2.9×10^{-4}	9.2×10^{-5}
500	2.9×10^{-4}	9.2×10^{-5}
400	2.9×10^{-4}	9.2×10^{-5}
315	4.1×10^{-4}	9.2×10^{-5}
250	5.2×10^{-4}	9.2×10^{-5}
200	1.2×10^{-3}	9.2×10^{-5}
160	2.3×10^{-3}	9.2×10^{-5}
125	4.1×10^{-3}	9.2×10^{-5}
100	1.5×10^{-3}	9.2×10^{-5}
80	3.8×10^{-4}	9.2×10^{-5}
63	3.8×10^{-4}	9.2×10^{-5}
50	3.8×10^{-4}	9.2×10^{-5}
40	2.9×10^{-4}	9.2×10^{-5}
31.5	2.9×10^{-4}	9.2×10^{-5}
25	5.2×10^{-4}	9.2×10^{-5}

the background fluctuated above peak levels.

(2) The magnitude of these acceleration values are roughly an order of magnitude or more below levels where individuals begin to perceive vibration. On this basis, the vibration would appear to be inconsequential. Seismic shock limits (Ref. 3) for building structures define a caution zone of approximately 0.01 g's which is well above the maximum acceleration level measured at the Mission. The measured vibration levels were also well below the structural damage threshold criteria adopted by the US Bureau of Mines (Ref. 4). If one assumes simple harmonic motion (sine wave) the displacement can be easily calculated from the acceleration values using the following relationship.

$$\text{Displacement} = \frac{\text{Acceleration (inches/sec}^2\text{)}}{4\,\pi^2\,(\text{frequency})^2}$$

The resulting displacement values were orders of magnitude below displacement limits specified for safety from seismic shock damage.

(3) The Civilian Conservation Corps (CCC) restored the Mission ruins from 1934 to 1941. During the restoration certain construction modifications were made to make the buildings stronger, safer and more resistant to earthquakes. These modifications included the use of reinforced concrete columns, girders, beams and massive wooden beams. These construction modifications significantly reduce the vibration damage potential to the restored Mission as compared to the original adobe construction and the vibration levels measured during the missile launch would have little if any effect on the Mission.

SECTION IV

CONCLUSIONS

1. These noise data and similar data can be used to predict noise levels at distances other than those specified in this report and for future launches. The effects of varying atmospheric conditions are minimized because low frequency noise is not significantly affected by normal variations in atmospheric conditions; however, any extreme deviations from average atmospheric conditions should be considered when extrapolating these data.

2. No significant environmental impact is expected to result from these launches at distances of eight miles (44,000 ft) or greater from the

launch site. The relatively short duration of noise and infrequent occurrence of these launches further reduces the acoustical impact. These launches would probably be tolerated by personnel residing at closer distances, i.e., four miles from the launch pad.

3. The acceleration (vibration) levels, even-though unsophisticated and measured at only one location within the Mission, were so small that it is inconceivable that any damage to the La Purisima Mission buildings could result from the vibration caused by these launches. However, noise levels were also measured at the Mission by personnel of the Bioacoustics Division, Aeromedical Research Laboratories and these data should also be considered with regard to information presented in Figures 11 & 12 before any definite conclusions are drawn regarding the damage potential of these launches.

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APPENDIX A

SIMPLIFIED UNCERTAINTY ANALYSIS OF RECORDING & ANALYSIS SYSTEMS

A simplified uncertainty analysis was performed on the recording and analysis systems. Sources of error in recording include variations in microphone incidence angle, tape characteristics, non-linearity characteristics of the octave band analyzer, recorder, playback unit and real time analyzer, and calibration instrumentation uncertainties. The uncertainty in the incidence angle has the potential for the largest single error in the system as it seriously affects microphone sensitivity, especially at high frequencies. The limit of error calculation for the system is listed below. The final uncertainty (limit of error) in the data presented is the rms uncertainty of the components and was calculated to be ± 1.9 dB.

PARAMETER	Limit of Error (dB) (RE: 20 $\mu N/m^2$)
Ampex 434 uniformity (reel to reel)	± 1.0
Ampex AG-350 reproducer (estimated non-linearity)	± 0.1
Uher 2000L recorder (estimated non-linearity)	± 0.5
1558 Filter uncertainty	1.0
Microphone Angle of Incidence	± 1.0
Real Time Analyzer non-linearity	± 0.5
data limit of error = λ =	± 1.9

APPENDIX B

ACCUSTIC DATA TITAN III LAUNCHES
(SAMSO/LVRO)

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS SPACE AND MISSILE SYSTEMS ORGANIZATION [illegible]
[illegible] ANGELES AIR FORCE STATION, PO BOX [illegible] WORLDWAY POSTAL CENTER
LOS ANGELES, CALIFORNIA 90009

LVRC 26 AUG 1974

[illegible] Measurements on Titan III Launches

[illegible]

1. As part of a DOD directed study on STS siting at Vandenberg AFB, we are reviewing the limitation imposed on potential sites by acoustic energy levels.

2. To obtain current acoustic data on launch vehicle systems similar to the Space Shuttle, request you obtain data per the attached requirements document on the next Titan IIIC, IIID, and IIIE launches. We understand that these data can be obtained through a currently planned measurements program and, therefore, at no cost to the program office.

3. Three copies of the resulting data and analyses (overall and octave band sound pressure level histories vs time and background level) should be forwarded to SAMSO/LVRO, Maj A.B. Sloan, Autovon 833-15[illegible].

[illegible signature]
[illegible]RRY W. [illegible], Lt Col, USAF
[illegible] Program Director, Ops & Eval
[illegible]usable Launch Vehicles SPO

1 Atch
Acoustic Measurements Requirements

Cy to: [illegible]
[illegible]
[illegible]
6555[illegible]
6595 [illegible]
Aerospace/J. Smith
Aerospace/P. Fortunova
Aerospace/R. Kendall

35

ACOUSTIC MEASUREMENTS REQUIREMENTS

1.0 PURPOSE

To outline requirements for monitoring and for field acoustic [illegible] of Titan IIIC, IIID, and IIIE [illegible] vehicles at Cape Canaveral AFS and Vandenberg AFB.

2.0 SCOPE

This plan covers the identification of acoustical and meteorological measurements and analyses necessary to obtain and evaluate overall root-mean-square sound pressure levels in decibels vs range time and [illegible] spectral distributions for time periods of particular interest. [illegible] sites are recommended to document sound propagation [illegible] distances from launch sites and for obtaining Lompoc area [illegible] levels.

3.0 ACOUSTIC MEASUREMENTS

3.1 INSTRUMENTATION

An audio pick-up/recording set is required for each observation station. Audio instrumentation need not be identical at each station but must have similar operating characteristics and be calibrated so that the recorded data referenced to a common standard may be [illegible] compatible station-set to station-set. This is essential to eliminating pick-up/recording instrumentation as a source of discrepancy in observed data. A positive correlation station-to-station and with range time must be established at rocket ignition and be maintained throughout vehicle lift-off.

Figure 1 represents the estimated overall sound pressure [illegible] expected to be generated by Titan IIIC, IIID, and IIIE vehicles at launch at different distances from the launch site. The approximate spectral content of the launch sound is shown in Figure 2. Figure 1 and 2 are to be used in evaluating and selecting appropriate audio pick-up and recording components.

3.2 [illegible]

For overall and octave band sound pressure level/time histories, appropriate calibrations must be maintained to assure [illegible]/input levels from the recorded [illegible] analyzed [illegible] correctly correlate sound levels with range time.

4.0 MEASUREMENT SITES - VAFB

[illegible] acoustic measurement site are shown in Figure 3 for the VAFB/Lompoc area. Sites situated roughly on four radials from SLC-6 have been indicated. Most of these have been located at existing installations to take advantage of existing electric power for the pick-up/recording sets (although battery powered sets need not be precluded from use) and to simplify coordination of recorded data with range time.

Since sufficient recording sets for each site may not be available, priorities have been assigned to the suggested sites as follows:

Priority	Site
1	La Purisima Mission
2	Radial 2
3	Radial [illegible]
4	Radial 1
5	Radial 3

SAMSO is publicly committed to making acoustic observations at La Purisima Mission. Following that, priority is given to obtaining data at a minimum of three different distances from the launch pad preferably along the same radial. Since the existence of background sound level data from the VAFB/Lompoc area is unknown, suggested sites are indicated on Figure 3 to be instrumented singly or simultaneously over a period of several weeks to characterize prevailing neighborhood noise.

5.0 [illegible] SITES - [illegible]

Acoustic measurement sites used by NASA for monitoring Saturn V launches are shown on Figure [illegible] [illegible] in acoustic [illegible] [illegible] common measurement sites may provide useful comparisons.

6.0 [illegible] MEASUREMENTS

At both [illegible] and VAFB, print-outs of wind systems data observed at selected stations during a vehicle launch period will be required. Specific data required at lift-off are:

a. Wind Speed — each station
b. Wind Direction — each station
c. Temperature — each station
d. Barometric Pressure — as available
e. Relative Humidity — as available
f. [illegible] data (vertical wind, temperature, density profiles of atmosphere).
g. Solar radiation — as available

[illegible] of [illegible] Meteorological [illegible] will be required to locate the more significant observation stations.

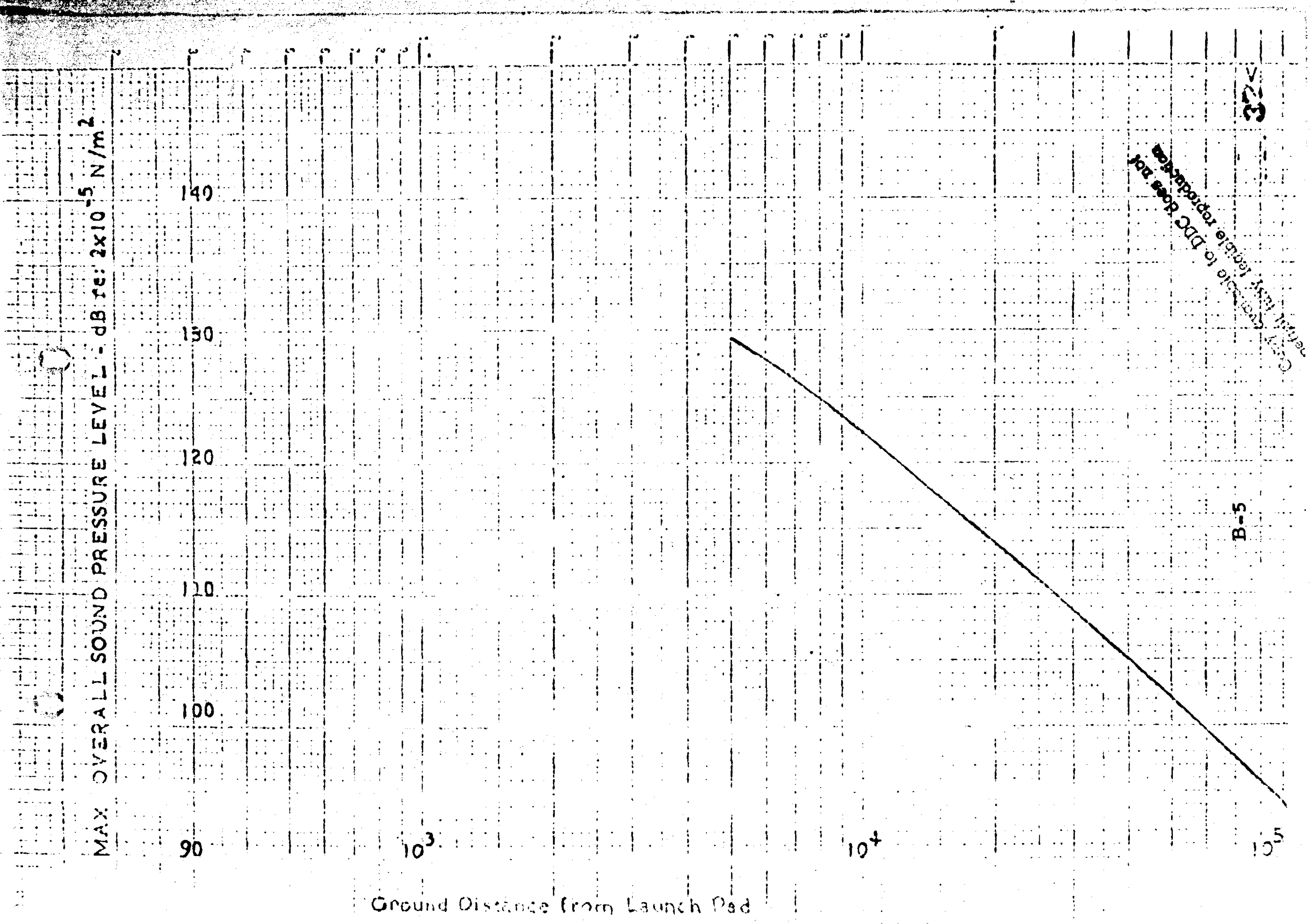
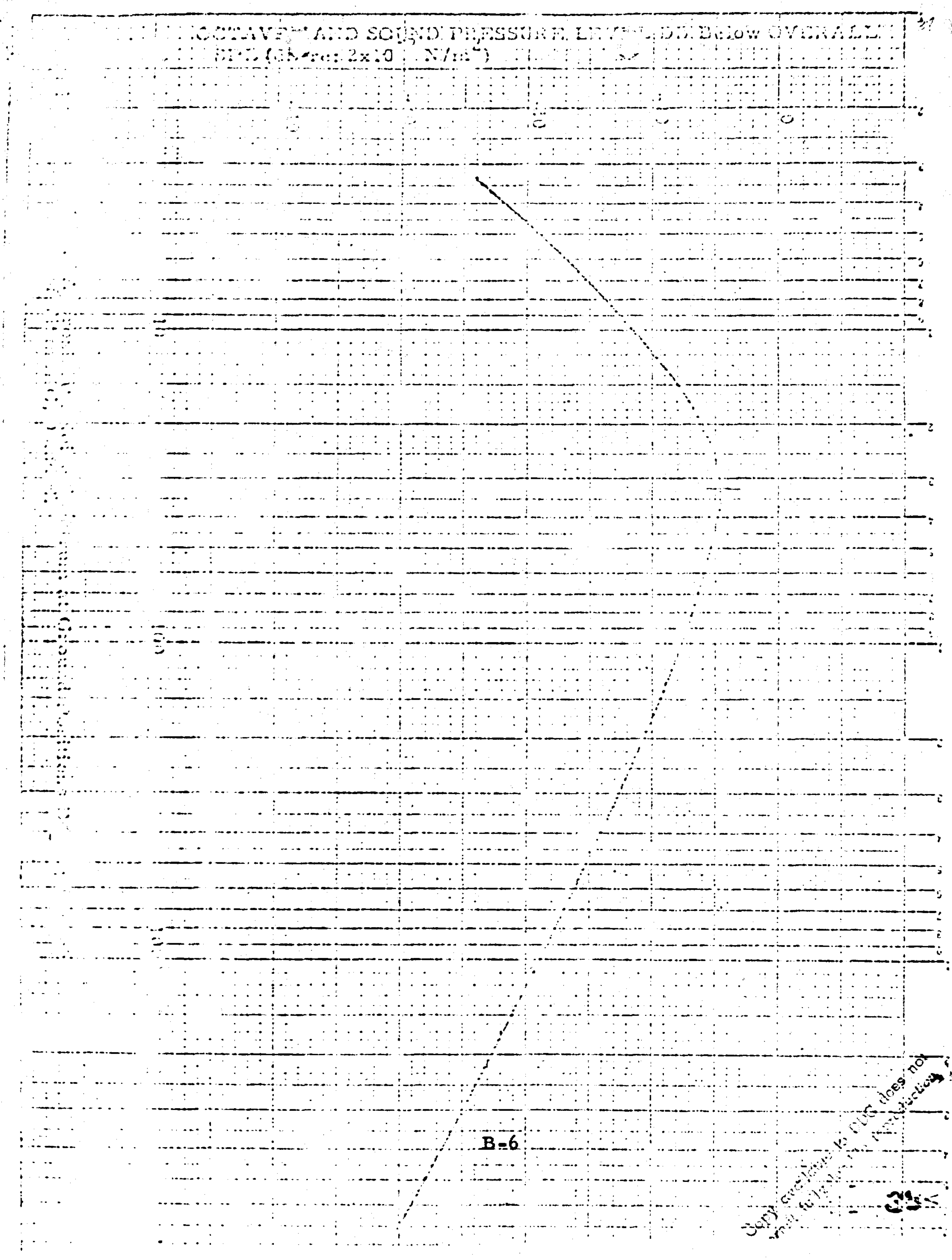


Fig 1 Estimated T-IIIC, D, E launch Overall Sound Pressure Levels vs. Ground Distance from Launch Pad.


OCTAVE AND SOUND PRESSURE LEVEL, DB Below OVERALL
SPL (dB re: 2x10 N/m²)

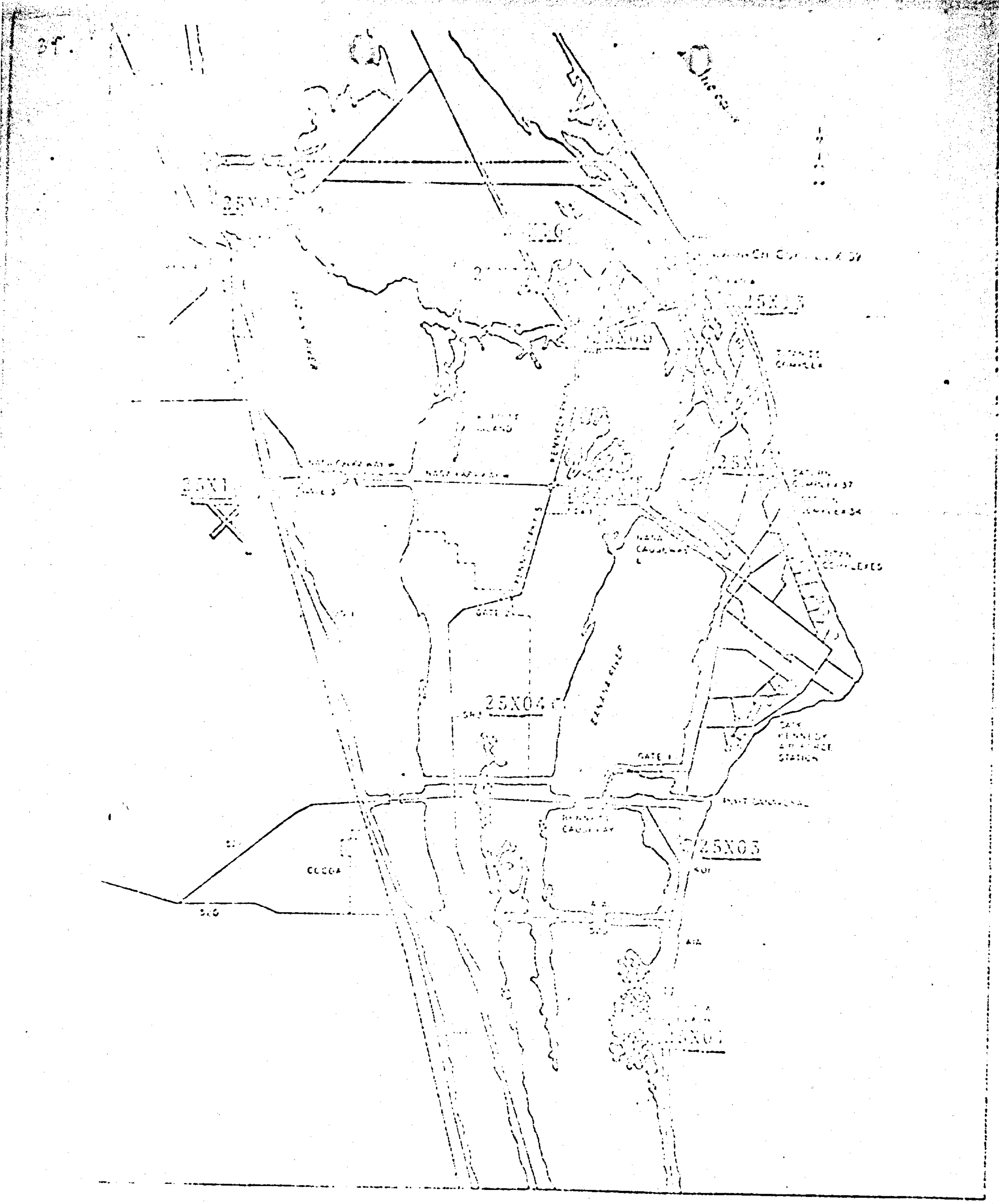


Figure . . Far Field Acoustic Measurement Locations CCAFS

APPENDIX C

WEATHER DATA 29 OCT 74
VANDENBERG AFB

NNNNVZCZCGV0070
RTTUZYUW WE 3795 3022256-UUUU--WE.
ZNR UUUUU
ZNR UUUUU
R 292230Z OCT 74
FM WEAV VAFB CA
TO AFSCF (DOW) SUNNYVALE CA
ASN BLDG 21150
BT

TEST NBR 07122 T-0
RAWINSONDE RUN AN/GMD-1
BLDG 900 - VAFB, CALIF.
1940Z 29 OCT 1974
ASCENT NBR 0109

WIND TEMPERATURE (°C) RELATIVE HUMIDITY (%)

ALT (FT)	DIR	KTS (SPEED)	TEMP	D/PT	PRESS	RH	AB/H	DEN	IR	VS	SHR	SVD
000367	300	013	14.5	6.9	0995.00	060	07.50	1200.72	313	661	0000	000
001000	319	017	12.1	6.7	0972.51	080	06.57	1182.39	316	658	.010	002
002000	320	016	9.2	6.0	0937.71	080	07.18	1158.45	301	655	.002	113
003000	329	017	6.6	2.5	0903.80	074	05.66	1121.26	285	652	.004	037
004000	337	016	4.5	1.5	0870.82	079	05.32	1088.32	270	649	.005	030
005000	340	025	2.7	.9	0838.84	088	05.11	1056.43	268	647	.011	349
006000	337	035	1.6	-2.4	0807.83	075	04.05	1021.96	254	646	.009	319
007000	331	033	.5	-6.5	0777.06	060	02.98	0988.68	239	644	.008	293
008000	327	032	-2.0	-8.7	0745.84	056	02.54	0957.10	230	643	.004	203
009000	335	027	-1.2	-10.9	0720.85	047	02.13	0922.01	219	642	.011	114
010000	330	025	-3.7	-11.7	0693.80	050	02.00	0892.50	212	641	.003	029
011000	336	032	-4.8	-12.8	0667.61	054	01.85	0865.59	205	638	.008	325
012000	334	036	-5.7	-14.9	0642.25	048	01.56	0835.79	196	637	.007	315
013000	332	037	-7.6	-16.4	0617.72	049	01.39	0809.53	189	635	.002	277
014000	331	038	-9.9	-18.2	0593.96	051	01.20	0785.44	183	632	.002	275
015000	333	039	-12.3	-19.5	0570.90	[illegible]	01.08	0761.77	177	629	.004	013
016000	337	044	-14.9	-21.4	0548.59	057	00.92	0739.56	171	626	[illegible]	010
017000	341	045	-17.2	-23.9	0526.85	055	00.75	0716.56	165	623	.009	[illegible]
018000	344	053	-19.3	-26.4	0505.54	054	00.60	0696.97	159	621	.009	020
019000	346	056	-23.0	-27.2	0485.47	063	00.56	0673.15	154	[illegible]	.005	006
020000	347	062	-24.7	-28.0	0465.73	081	00.38	0652.76	150	614	.012	355
021000	351	069	-27.1	-29.7	0446.61	079	00.46	0632.14	144	611	.013	026
022000	353	063	-29.3	-32.1	0428.05	077	00.37	0611.38	139	[illegible]	.011	152
023000	352	061	-32.3	-36.2	0410.13	[illegible]	00.23	0593.11	134	[illegible]	.003	195
024000	351	061	-34.4	-42.6	0392.75	044	00.13	0573.10	129	602	[illegible]	203
025000	350	061	-38.0	-45.0	0375.90	034	00.08	0554.25	124	599	.008	256
026000	340	061	-39.5	99.9	0359.76	999	99.99	0536.32	120	596	[illegible]	001
027000	345	062	-42.5	99.9	0344.05	999	99.99	0519.64	116	592	.003	300
027000	345	064	-45.4	99.9	0328.01	999	99.99	0502.91	112	588	.008	330
029000	345	065	-48.1	99.9	0314.09	999	99.99	0486.23	108	584	.008	006
030000	349	065	-51.1	99.9	0299.06	999	99.99	0470.42	105	581	.002	058
031000	349	065	-59.6	99.9	0286.17	999	99.99	0447.95	100	581	.001	158
032000	348	074	-51.4	99.9	0273.15	999	99.99	0423.96	096	580	.016	337
033000	347	083	-48.1	99.9	0260.76	999	99.99	0403.67	090	584	.016	357
034000	345	077	-45.6	99.9	0249.09	999	99.99	0381.40	085	588	.010	185
035000	343	071	-46.6	99.9	0237.96	999	99.99	0365.98	082	586	.013	189
036000	339	065	-48.9	99.9	0227.29	999	99.99	0353.10	079	583	.011	198
037000	337	063	-49.4	99.9	0217.01	999	99.99	0337.94	075	583	.006	210
038000	335	066	-49.3	99.9	0207.19	999	99.99	0322.52	072	583	.006	297

037000	337	000	[illegible]	99.9	[illegible]	[illegible]	99.99	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
038000	335	006	-49.3	99.9	[illegible]	[illegible]	99.99	0322.52	072	585	.006	[illegible]
039000	333	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
040000	332	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
041000	331	071	[illegible]	99.9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	581	.001	307
042000	333	067	-52.5	99.9	0172.06	999	99.99	0271.69	061	579	.007	133
043000	334	059	-54.0	99.9	0164.16	999	99.99	0259.77	058	578	.014	141
044000	332	050	-52.2	99.9	0156.63	999	99.99	0246.97	055	579	.015	167
045000	324	042	-52.1	99.9	0149.46	999	99.99	0235.58	052	579	.017	186
046000	316	038	-53.4	99.9	0142.60	999	99.99	0226.18	050	577	.012	194
047000	316	037	-54.6	99.9	0136.03	999	99.00	0216.82	048	576	.007	214
048000	309	035	-55.3	99.9	0129.72	999	99.99	0207.48	046	575	.003	146
049000	309	035	-55.3	99.9	0123.70	999	99.99	0197.79	044	575	.001	105
050000	306	035	-55.6	99.9	0117.96	999	99.99	0188.87	042	575	.004	240
051000	301	037	-57.0	99.9	0112.48	999	99.99	0180.46	040	574	.005	236
052000	296	036	-56.9	99.9	0107.23	999	99.99	0172.78	038	573	.006	196
053000	290	032	-56.7	99.9	0102.23	999	99.99	0164.55	037	573	.009	152
054000	284	027	-58.0	99.9	0097.45	999	99.99	0157.09	035	573	.010	137
055000	277	023	-57.9	99.9	0092.89	999	99.99	0150.32	033	572	.008	142
056000	273	021	-58.3	99.9	0088.53	999	99.99	0143.57	032	571	.004	142
057000	269	020	-58.9	99.9	0084.36	999	99.99	0137.15	031	570	.003	133
058000	263	018	-60.5	99.9	0080.37	999	99.99	0131.66	029	568	.005	133
059000	262	016	-61.5	99.9	0076.55	999	99.99	0125.97	028	567	.003	097
060000	265	014	-63.0	99.9	0072.90	999	99.99	0120.30	027	566	.004	060
061000	279	013	-61.9	99.9	0069.41	999	99.99	0114.50	026	566	.006	023
062000	300	014	-61.3	99.9	0066.10	999	99.99	0108.60	024	567	.009	008
063000	299	011	-60.6	99.9	0062.96	999	99.99	0103.20	023	568	.005	124
064000	259	006	-59.9	99.9	0059.96	999	99.99	0097.79	022	569	.013	149
065000	189	009	-58.1	99.9	0057.16	999	99.99	0092.61	021	571	.016	152
066000	178	013	-58.4	99.9	0054.48	999	99.99	0088.36	020	571	.007	153
067000	177	015	-58.1	99.9	0051.92	999	99.99	0084.10	019	571	.004	167
068000	194	018	-58.5	99.9	0049.48	999	99.99	0080.31	018	571	.010	325
069000	223	008	-58.9	99.9	0047.16	999	99.99	0076.68	017	570	.009	323
070000	227	010	-58.1	99.9	0044.94	999	99.99	0072.81	016	571	.002	250
071000	215	013	-57.9	99.9	0042.83	999	99.99	0069.33	015	572	.006	165
072000	207	016	-57.6	99.9	0040.83	999	99.99	0065.98	015	572	.007	183
073000	207	019	-58.1	99.9	0038.92	999	99.99	0063.06	014	571	.004	206
074000	210	022	-57.9	99.9	0037.09	999	99.90	0060.03	013	572	.006	226
075000	215	026	-55.7	99.9	0035.37	999	99.99	0056.67	013	574	.007	236
076000	219	027	-53.9	99.9	0033.73	999	99.99	0053.59	012	577	.004	276
077000	225	025	-53.2	99.9	0032.18	999	99.99	0050.98	011	578	.006	352
078000	229	025	-54.0	99.9	0030.71	999	99.99	0048.59	011	578	.003	326
079000	233	024	-52.8	99.9	0029.30	999	99.99	0046.34	010	578	.003	352
080000	237	022	-52.9	99.9	0027.96	999	99.99	0044.22	010	578	.005	010
081000	242	022	-53.5	99.9	0026.68	999	99.99	0042.31	009	577	.003	332
082000	247	024	-53.5	99.9	0025.46	999	99.99	0040.37	009	577	.005	289
083000	252	026	-53.2	99.9	0024.29	999	99.99	0038.48	009	578	.005	295
084000	256	026	-53.3	99.9	0023.18	999	99.99	0036.73	008	578	.004	333
085000	261	025	-53.0	99.9	0022.12	999	99.99	0034.83	008	579	.004	018
086000	264	025	-51.4	99.9	0021.11	999	99.99	0033.16	007	580	.002	028
087000	266	024	-50.9	99.9	0020.15	999	99.99	0031.59	007	581	.002	018
088000	263	022	-49.8	99.9	0019.24	999	99.99	0030.01	007	582	.004	114
089000	257	021	-49.3	99.9	0018.38	999	99.99	0028.60	006	583	.004	152
090000	248	021	-48.9	99.9	0017.55	999	99.99	0027.26	006	583	.006	165
091000	239	023	-48.5	99.9	0016.76	999	99.99	0026.00	006	584	.007	177
092000	232	026	-47.9	99.9	0016.01	999	99.99	0024.76	006	585	.007	190
093000	233	029	-48.2	99.9	0015.20	999	99.99	0023.68	005	584	.005	239
094000	999	999	-48.4	99.9	0014.61	999	99.99	0022.65	005	584	.999	999
095000	999	999	-48.6	99.9	0013.95	999	99.90	0021.65	005	584	.999	999
096000	999	999	-48.3	99.9	0013.33	999	99.99	0020.65	005	584	.999	999
097000	999	999	-49.0	99.9	0012.73	999	99.99	0019.70	004	585	.999	999